Visualisation of synaesthetic experience during the early 20th century – an analytic approach

Dr. Michael Haverkamp, Köln

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1. Introduction: early literature on synaesthesia

While synaesthetic experience is seldom mentioned before mid of the 19th century, the scientific and public interest strongly arose during the second half of the century. A quickly growing number of publications caused a kind of “synaesthetic euphoria”, which continued during the 1920’s and 1930’s, reaching a summit with 3 German conferences and various publications of the “Farbe-Ton-Forschung”, being more a movement than only a new, specialised scientific and artistic discipline.
The first sources mentioning synaesthesia came up for discussion. Wellek (1930, S.328f) notes that the English eye specialist John Thomas Woolhouse gave the earliest report on this topic in the beginning of the 18th century. In 1735 Louis Bertrand Castel reported this observation of a blind subject with coloured sense of touch. The most cited source is given by John Locke (1690), who wrote about a blind man who described the colour *scarlet* by the timbre of a trumpet.

The romantic era was characterized by the wish of artists to include a mixing of sensual experience into their works. Especially literature shows many examples of synaesthetic expressions. An in-depth analysis of this phenomenon is not the topic of this publication, but is given by various authors, like Schrader (1969) and Wanner-Meyer (1998). Compared to the long-lasting research on the period of romanticism, the question, whether literary synaesthesia has also been present during antiquity and the middle age or not, is quite new and a topic of today’s discussions (e.g. Jahrestagung der Gesellschaft für Musikforschung, Düsseldorf 2002; Catrein 2003).

The first approaches to comprehensively analyse the phenomena of synaesthesia where made during the last quarter of the 19th century by Bleuler and Lehmann (1881), Théodore Flournoy (1893) and Suarez de Mendoza (1890). Their publications tried to find principle laws of cross-modal perception and gave proposals of terminology. Although various definitions were made to specify the phenomena in order to enable scientific approaches, an upcoming confusing could not be avoided. A large number of specific phenomena were summarized by terms chosen too specifically: e.g. “synaesthesia” and “association”. In contrary, many words appeared with overlapping (redundant) meaning: e.g. “audition colorée”, “Farbenhören”, “colour(ed) hearing”, “Synopsie”, “Chromasthesie” etc. In Germany, “Mitempfinden“ and "Doppelempfinden“ were common words for all kinds of synaesthesia. Until today, synaesthesia has specific, but very different meaning in different disciplines: a perception stimulated via a different modality (medicine), a verbal construction (literature) or a consciously designed multimedia event (arts, film).

During the 1920’s Friedrich Mahling (1927) and Annelies Argelander (1927) published two important bibliographies. Wellek (1930, S. 369f) gave a critical review of both works and added some references. The reviews cited a large number of more than 800 (!) publications dealing with either scientific approaches or literary sources and individual case studies. Wellek criticised the lack of distinguishing between scientific papers and literary sources within publications on synaesthesia.

While many verbal descriptions of synaesthetic experience existed even at the beginning of the 20th century, the general problem of verbal description of sensational phenomena induced a limited accuracy of scientific approaches. This principle deficiency was amplified by lack of specific terminology (and – in the beginning of psychology – by lack of experimental methodology).
With respect to this background, experiments are of specific interest including trials of graphic visualisation of visual-synaesthetic sensation. Various results have been published in-between 1925 and 1936. While those pictures include different aspects of cross-modal binding, according to the summation of different phenomena under specific terms, an analysis model will be introduced first which proves to be suitable to separate those incoherent attributes and enables a scientific approach even more than 70 years after publication of the synaesthetic pictures.
This model is also appropriate to analyse recent synaesthetic visualisations, as presented by Emrich et al. (2001), which also very often show correlation of visual sensation and other modalities on more than one level of interaction.
Even if scientists are dealing with genuine synaesthesia, it is necessary to separate the phenomena from others and carefully design the experimental conditions in a way that minimizes the influence of concrete associations and of constructions made up consciously.

2. A model of cross-modal links

In order to separate the various links in-between different modalities to enable analysis of complex results of binding, a simple model is proposed (Fig. 1). It consists of 5 levels of inter-modal correlations. As an example, the case of visual perception caused by auditory stimulation is drawn.
The scheme follows classical hierarchical structures, with genuine, fixed (non contextual) properties below, more context-driven properties in the middle and consciously constructed relations on top. For analytical application of the model, however, there is no need of a hierarchical ranking of each level. All levels excluding the top level can show emotional contribution, but this is viewed at to be a secondary, collateral effect and is therefore excluded from analysis.
Imagination can also act stimulating, thus causing visual perception or imagination, as stated by Wellek (1930, S. 326f).

3. Model properties

The model is designed to be suitable for classification of inter-modal phenomena. It includes simplification of the processes which can be assumed to be much more complicated. Instead of 5 levels, possibly thousands of links may exist. From the nature of dynamic grouping processes and the not very specific neuronal structures in different areas of the cortex (Singer 1997) it can be concluded that fixed borders between different kinds of processes do not exist. While presumably millions of neuronal processes are performed simultaneously, all kinds of inter-modal processes probably merge within a multi-dimensional continuum, impossible to be handled analytically.
Thus, although the model refers to classical hierarchical models with “lower”, genuine (possibly physiological determined) and “higher” cortical connections, it is not intended to include distinct relations to brain "topography". The “rules” defined below do not effort a hierarchical organization. The one exception is given by the “pre-processing” sub-systems that can be anatomically identified as separated physiologic units (e.g. receptor cells, neuronal fibres and nuclei).

With the basic simplifications included and the assumption of fixed borders the model provides a clear determination of functions. Each level contains sublevels used to classify the various phenomena reported in literature.

4. Rules of inter-modal linking

Results of inter-modal links are analysed with the model regarding the “rules” listed below:

I. The connection between modalities can simultaneously be performed on various levels. This principle of **parallel processing** is in accordance to recent findings of brain functionality. It also refers to daily experience that – e.g. during perception of music – it is possible to experience a concrete association at one time with a sensation of brightness and with conscious analysis of the musical structure.

II. Each active level gains an **independent result** that can be contradictory to other levels. Some synaesthets report this conflict as an unwell feeling, e.g. in case if the associative content of a word describing a colour is not in accordance to the colours induced with their colour-graphemic synaesthesia.

III. While levels are acting independently, various levels can provide similar results. Therefore it is not possible to conclude from an artistic work (e.g. a picture or lyrics) with inter-modal aspects on one specific mechanism behind. Until the mid of the 20th century this conclusion was often made, describing all artists referring to inter-modal coupling as being synaesthets. On the other side, if a specific level of interaction is identified, all other levels must be additionally taken into consideration. E.g. the fact that the coloured light of Scriabins “Prometée” refers to symbolic aspects of colour does not necessarily exclude the possibility that he could also have shown genuine synaesthesia. Various authors, however, try to declare artists as non-synesthetic if symbolic or associative links have obviously been used to construct artwork (Harrison, 2001; Jewanski, 2002).

A clear identification of the relevant “mechanism behind” is impossible without comprehensive information provided by the artists themselves. This is the reason why it is not easy – but nevertheless essential – to carefully design experiments dealing with synaesthesia in order to force the test persons to the level of interest and systematically exclude all other levels.

IV. The results provided by different levels can be combined or discarded consciously. This fact enables an artistic talented synaesthet to include several inter-modal relations into his works – or to disregard them. Behne (1998) is right claiming that synaesthesia is not suitable as an aesthetic paradigm. A simple reproduction of visual sensations will not be accepted as real artistic work, but will be assessed like a simple naturalism copy of views of human’s environment. Synaesthesia, however, can give main impulses on artistic creativity and – if other levels are included into artistic works – can help to organize complex material and can therefore enable high artistic performance (e.g. regarding compositions of Oliver Messiaen and György Ligeti).

V. Inter-modal relations of an artwork can refer to different levels at the sender and the recipient. E.g. literary synaesthesia is a conscious construction of words, but needs a reader with associative capabilities and/or inter-modal analogies to be

understood. Ch. Ruths (1898) proposed a bold theory assuming that in principle a composer refers to his own visual imagination, then systematically transforms it into music, which during performance enables the listener to exactly reproduce the initial image. This assumption fails with awareness of the various levels of interaction, giving a vast number of possible results.

5. Levels of interaction

While the model described above only gives a rough classification of possible inter-modal links, each level contains various phenomena as follows:

5.1. Psychophysics

The lowest level in the hierarchic structure of stimuli processing is well described by results of psychophysical experiments. This level does not enable any inter-modal coupling but is here included while it provides the basic handling of stimuli. Serial units with fixed function, fully determined by the physiological properties, perform the signal processing. In the human auditory system, it includes the outer ear with auricle and ear channel, eardrum and middle ear bone structures, cochlea with perceptive cells and the first neuronal centres: nucleus cochlearis, olivae, colliculus inferior, nucleus geniculatus medialis and finally the auditory cortex. In the visual system, it consists of the eye with the retinal receptors, the chiasma opticum, the nucleus geniculatus lateralis and the visual cortex (occipital). Although most pioneers of psychophysics included discussions on synaesthetic coupling into their research, e.g. Herrmann von Helmholtz (1860), Wilhelm Wundt (1874) and Gustav Theodor Fechner (1876), this discipline more and more focused on basic functions of pre-processing, excluding topics of psychology. Inter-modal analogies, associations and metaphors, however, remained as an integral part of psychophysical experiments.

5.2. Genuine Synaesthesia

Synaesthetic experience is often described in literature of the last 130 years. At first, the word was used for a wide range of phenomena of cross-modal coupling. During the last 20 years, a more precise and exclusive definition was aimed at. The specific phenomena of genuine synaesthesia are here regarded according to the definition of Cytowic (1989), who played a main role in rendering the nomenclature more precisely and who released the renaissance of synaesthesia at the end of the 20th century. The term “genuine synaesthesia” now distinguishes the specific phenomena from other ways of cross-modal coupling like associations, inter-modal analogies or mathematical suggestions. Recent publications further clarified the singular and individual nature of genuine synaesthetic experience (Emrich et al., 2001; Harrison, 2001).

Bleuler and Lehmann (1881) published the first scientific book on synaesthesia written in German. The authors used the term “Zwangsmäßige Lichtempfindungen" for description of visual sensation caused by stimulation of other modalities. They also used “Pho**t**ismen” for this case and “Pho**n**ismen” in case of auditory sensation caused by visual stimuli, a wording that became common while it was agreed by other scientists. Flournoy (1893) also defined “Synopsie” as the visual synaesthetic sensation. Anschütz (1927a, 1927b) distinguished “Analytische Synopsie” from “Komplexe Synopsie”. „Analytische Synopsie“ means a single visual attribute (e.g. colour or shape) induced by a single attribute of another modality (e.g. sound pitch or timbre). In contrary, stimuli and sensation of “Komplexe Synopsie” contain a sum of

attributes. In this manner a complete musical composition can cause a complex image including colours, various shapes, movement, variability in time, spatial properties and further attributes.

For analysis of synaesthetic visualisations, various sub-categories are taken into account in order to identify genuine synaesthesia. **Colour hearing** describes colours related to auditory attributes, including relations to timbre and pitch. Anschütz (1927a) discusses a colour scale reported by Paul Dörken that shows a fixed correspondence of pitch and colour. Each musical tone induces a specific colour, independently of its octave. This fixed correlation of pitch to a visual attribute is only possible in connection with the capability of absolute pitch perception. In general, genuine synaesthesia shows some parallel to absolute pitch perception, regarding its independence from contextual parameters, assumed inheritance and invariance over a lifetime.

Shapes induced by genuine synaesthesia are characterised as simple and abstract **basic forms**, which normally do not appear within paintings of non-professional painters, in particular during the first half of the 20th century, while abstract art struggled to gain common acceptance. The appearance of basic visual forms has also been described after drug abuse and can be induced by electric or magnetic stimulation of the brain. Fig. 2 gives examples of basic forms stimulated by music, as reported by Anschütz 1927b:

The upper left image shows bubbles that were seen moving slowly downwards while listening to the final part “Feuerzauber” (Fire Spell) of Richard Wagner’s opera “Die Walküre” (The Valkyrie). The painter Max Gehlsen relates it to the musical leitmotif “Schlafmotiv” (sleep motif), which consists of a chromatic downward movement of chords, while he states that the image of bubbles are caused by the sound of accompanying harps. The lower left image is related to the final part “Liebestod” of Wagner’s opera “Tristan und Isolde”. It is reported to appear during measure 11, which after a long crescendo contains the first highlight of the final part. Within the lower right picture, Gehlsen shows another coloured shape related to the final part of “Die Walküre” that appeared after the “Schlafmotiv” with the motif of *Siegfried,* which is declaimed by *Wotan*. This image consists of a rotating swirl with spraying sparks. The fourth picture placed upper right shows dark squares in front of a light background. The painter Heinrich Hein states that it is related to a popular song. The melody with small pitch range is characterised by staccato articulation, causing a group of small geometric shapes.

With respect to the fact that the left side pictures of fig. 4 are also related to the music of “Tristan und Isolde”, but show completely different visual elements, it becomes obviously that genuine synaesthetic images consist of unspecific, individual shapes that make it impossible to retrace the stimulating signal. This is an important criterion that distinguishes the genuine type of synaesthesia from other inter-modal links like *analogies* with systematic scaling properties, *associations* with shapes taken from real world and *symbols* that are commonly understood.

Basic forms often appear as bright shapes on a dark background. The so-called **phosphenes** can be seen in many visualisations prepared by synaesthetes. Examples are given within Fig. 4. Catalogues of principle shapes have been collected by various authors, e.g. Klüver (cited by Cytowic 1989), Horowitz (1970) and Eichmeier and Höfer (1974), who did extensive investigations using electrical and magnetic stimulation of test persons. The images on the left side by Max Gehlsen again refer to Wagner’s music of “Tristan und Isolde”, caused by the same measure of the final part where the “Tagesmotiv” (leitmotif of daylight) appears. Heinrich Hein prepared the other two pictures, from which the mid one refers to a composition by Edvard Grieg, “Hochzeit auf Troldhaugen”, part 3. Beside genuine attributes, this

image and the right one (Ludwig van Beethoven, Bagatelle op.33 no.5) show bright lines typical for the appearance of “notational synaesthesia” as discussed below.
Synaesthetic images can change with time even during stimulation with time variant signals like musical compositions. The change versus time naturally cannot be shown within one static picture. By use of picture series, Hein made impressive trials to demonstrate the progress of phosphenes over time, perceived during hearing of two folk-songs (Fig. 5).
Further sub-categories like **number forms** as first comprehensively analysed by Flournoy (1893) and **coloured letters** are included into the analysis. Coloured letters today are seen as the most prevalent type of synaesthesia, but were less often described in the early literature and interpreted as related to the sound of spoken language. Today it is known that it depends on a relation of character shape and induced colour, thus it is not a coupling in-between modalities but in-between different visual attributes. Fig. 3 shows the first visualisation of coloured letters, prepared by Lind, reprinted by Klein (1937). Voss (1929) provides examples of coloured images of Braille script often reported by blind subjects.
While the majority of visualisations concerns auditory stimulation, some other types of genuine synaesthesia can be found: Stimulation of other senses leads to **coloured tactile feeling**, **smell** and **pain**. In few cases **suggestion of a term** (an idea) or of a **person** causes appearance of complex visual images, exemplified by Reimpell and Anschütz (1929).

5.3. Inter-modal analogies

In contrary to the specific and idiosyncratic nature of genuine synaesthesia, it is a common human capability to form inter-modal analogies. Results of psychophysical experiments have shown that nearly every subject can make up analogies between attributes of different modalities. The results, however, contain a larger variability than those caused by genuine synaesthesia and show a certain dependence on the perceptual context. E.g. the visual brightness of a sound can depend on the properties of auditory signals perceived before.
In contrary, the genuine synaesthesia shows small variability and types of sensation that cannot easily be influenced by change of context parameters.
Inter-modal analogies often refer to attributes that are common for all modalities. Werner (1966) describes five main “Intersensorielle Eigenschaften” (inter-sensual properties):

intensity brightness volume density roughness

Behne (1992) tried to strictly distinguish between genuine synaesthesia (“Synästhesie sensu Cytowic”) and inter-modal analogies. In contrary, Anschütz (1927) and Marks (1975) described an influence of the analogous property “colour brightness” on the genuine synaesthetic sensation “hue”. Stevens (cited by Lindsay and Norman, 1981) showed that the intensity of sound can be described by test persons using other attributes of various modalities, e.g. vibrational magnitude, intensity of electrical stimuli, length of an object, number of objects, hardness and others. The methodology of “cross-modal matching” proved to be an important tool for psycho-acoustic evaluation.
The common prevalence of inter-modal analogies leads to the conclusion that they are enabled by inherent capabilities of the human brain. Wellek (1931a) established the term “Ursynästhesie” (ancestral synaesthesia). While inherited properties cannot easily be distinguished from cultural conditions developed during a long time, the

question remains unanswered whether “Ursynästhesie” really is a natural condition or a deeply rooted result of long term tradition.
One of the most important inter-modal relations is that of tone pitch to spatial height, thus establishing the common system of musical notation. The search for images which correlate closely to music often leads to structures with lines, showing height changes analogous to tone pitch. This phenomenon was named “Notations-Synästhesie” (notational synaesthesia) while it often appears as a mixture of genuine elements and the inter-modal analogy used in musical notation. Fig. 6 gives an example related to the 6th Hungarian Dance by Johannes Brahms. The painter Max Gehlsen reported that violet horizontal lines refer to the bass line, vertical pillars at the left hand side are caused by the string chords in the beginning and yellow rippled lines reflect fast movements of the melody, as analysed by Truslit (1931). The light-orange background colour refers to key and speed of the composition.
Experiments have been done by Rainer (1925) to visualise music with free and spontaneous drawing, carried out by pupils. Examples of the “Musikalische Graphik” (musical graphics) generated by this way are given within Fig. 7. Results show that inter-modal analogies thereby play an important role, especially shapes according to musical movement and to gesture of dance (see also Truslit 1931). The pictures more often refer to complete compositions than to specific stimuli picked up analytically, as provided by Anschütz.
Main problems of transforming musical elements into pictures are caused by difficulties transforming time dependent processes into spatial, motionless shapes. Use of motion pictures solves this problem, as shown by abstract musical films by Oskar Fischinger, which base the correlation of image and music on analogy of movement and synchronicity of changes. Synchronicity is one of the basic properties of multimedia visualisations recently used by video clip, lightshow, computer games and film.
Analysis of synaesthetic paintings was here done regarding the sub-categories **basic analogy** (volume, height, brightness, density etc.), **analogy to musical notation**, **analogy to musical movement** and **spatial analogy**.

5.4 Concrete association

While “association” is used in a variety of meanings, it is here specifically defined regarding concrete images from visual memory which can be identified as saved parts of objects seen before (synonym to *iconic representation*).
Pictures drawn by people declaring themselves as synaesthets often include such images, e.g. landscapes, space, buildings, rooms & halls and others, as exemplified by Fig. 8. The lower left image also appeared during listening to Grieg’s “Hochzeitstag auf Troldhaugen”, part 3. This time, the mood of the music gives the impetus for an association of a landscape with trees. With view on the fact that another image was prepared showing genuine and inter-modal attributes (see fig. 4 discussed above), the example illustrates that various levels of inter-modal correlation can dominate at different times. The mid picture reminds to a landscape, but includes a red ground surrounding a yellow path and high green pillars. The image appeared during remembrance of march music (“Hohenfriedberger Marsch”), but is interpreted by the painter Heinrich Hein to consist of key-related colours and structures with some analogy to the musical elements.
Reports of persons who became blind during childhood demonstrate that inter-modal links can play an important role to substitute vision (Voss 1930, 1936). The upper right image of fig. 8 shows a pavement structure obviously reconstructed from the perceived coach noise. The lower right example points at rolling balls as an associ-

ated process of sound generation that would cause a similar noise like the drum roll, which in fact was used as stimulus.
Especially onomatopoeic elements of noise and music can induce concrete images. Those images can refer to shape and colour of musical instruments, as shown in pictures of Blanc-Gatti (1934) and in Disney's animation film "Fantasia" (see e.g. Culhane 1983). In comparison to pure abstract musical films like those of Fischinger, Disney always added associative elements, trying to increase acceptance of an auditory assumed to be dismissive to abstract visualisations.
Classical theories of associative memory have been developed and discussed by Fechner (1876), Arnheimer (1977) and other scientists. Those approaches assume that sensations of various modalities are remembered in parallel if they formerly were caused by simultaneous stimuli. In practise, it is often difficult to prove this causality while "microscopic" fragments of a sensation can be connected to fragments of the other modalities involved. Within this study, associations are regarded if a clear identification is possible.
Some authors note that associations can be induced by basic forms or phosphenes, stimulated by other modalities, as described by Petersen (1931). This phenomenon can be seen as a *secondary coupling* of modalities, while the inter-modal connection is made-up by genuine processes, followed by a transformation to other levels of the visual modality.

5.5 Symbol and metaphor

Synaesthetic terms as a special kind of metaphor are an important element of literature, and were often used in lyrics and prose of the 19th century, as analyzed by Wanner-Meyer (1998; see also principle considerations of Wellek (1931b) and Schrader (1966)). Synaesthetic terms are also applied for description of sensations during psychophysical experiments. Those terms are primarily conscious constructions, but need the recipient's capability of imagination via inter-modal analogy or association.
Stimuli of a specific modality can also refer to symbolic codes, which e.g. are given in the visual area by signals and logos, often based on aspects of ancient heraldry. Those symbols can only be understood if sender and recipient are based on the same context. Therefore the functionality of signs and symbols is limited to specific aspects of culture and era. Gage (1993) gives a comprehensive insight into the colour meaning of the arts. Scrjabin included symbolic meaning into his coloured light added to "Prometée", which can only be understood by carefully reconstructing the philosophic background of the composer.

5.6 Mathematical and physical correlation

The physical analysis of auditory and visual stimuli shows some commonness. In both cases energy is transported to the sense organs via physical waves, which are of mechanical (sound) or electro-magnetic (light) nature. While the waves show equivalent behaviour in some manner, it was often tried to correlate both phenomena using mathematical transformations that were based on physical properties. A main difference is given by frequency (sound: 16-16000 Hz; visible light: 390-790 THz). Several trials have been made to directly relate frequencies (or wavelengths) of light to those of sound in order to construct light events similar to audible music. A musical system based on various octaves, however, cannot be established with visible light. The relative bandwidth of audible sound is more than 12 octaves, whereas visible light covers less than one octave (!). Another big difference is given by different

resolution of auditory and visual perception: frequency resolution of hearing is high compared with vision, whereas spatial resolution of the eye is much higher than that of the ear. A complex spectrum of sound can simultaneously lead to various perceptions like tones with pitch and timbre independent from each other, while every light spectrum only induces sensation of a single colour. Therefore a polyphonic structure cannot simply be transferred from sound to light by use of spectral properties, but must include transformation from the spectral domain to spatial properties. During the 17th century, Bertram Castel was the first to make up a concept of colour music including colours directly related to musical tones (pitch), but an instrument with convincing properties could not be prepared during his lifetime. Jewanski (1996) gives a detailed analysis of theories and trials up to the beginning of the 19th century. Many further trials were made, until Rimington (1911) wrote one of the first comprehensive books, followed by László (1925) and Klein ([1]1911). All three authors have build up colour organs that successfully were presented to public. Fig. 9 gives examples of suggested colour scales included into Rimington's publication. Technical progress during the 20th century improved availability of lighting systems for use in large-scale presentations. The interest in theoretical approaches in colour music, however, decreased after a euphoric phase within the first half of the century, and changed to more creative and free use of capabilities provided by light show, movie and video-clip.
Mathematical and physical correlations indicate possibilities of conscious construction of links between several modalities. This level of the model includes multisensory concepts of artistic work, as used by painters like v. Doesburg, Macke, Klee, Kandinsky and many others (see: Maur 1985). It also considers the abstract musical film, e.g. made by Ruttmann, Fischinger, Richter and Disney (Fantasia), although those approaches refer to (and use elements of) other levels like genuine synaesthesia and concrete association.

6.0. Anschütz: Farbe-Ton-Forschungen

In-between 1925 and 1936, Georg Anschütz initiated various activities in scientific research on synaesthesia. First, a psychological-aesthetic workgroup was founded at the Hamburg University. The increasing interest from psychological, pedagogic and artistic side cumulated in 4 congresses on "Farbe-Ton-Forschung" which took place in Hamburg in 1927, 1930, 1933 and 1936. Various documentations exist, spread over 3 books on "Farbe-Ton-Forschung**en**", published by Anschütz, and some other presentations. All books are of extraordinary interest to synaesthesia research while a large number of visualisations of photisma are shown for the first time. To increase readability of this text, the acronym **FTF** will further on replace "Farbe-Ton-Forschungen".
The relation of the 3 volumes of FTF to the subject of the congresses held is quite different. Table 1 intends to clarify the confusion:
This first book of FTF was published January 1927 before the 1. congress was opened. It contains 4 papers by Anschütz, Hein and Mahling published before.
The 2nd book was published 5 years after the 3rd volume. One of its main articles dealing with synaesthesia of blind subjects was published earlier (Voss 1930, an extended version of an article published 1929, "Archiv für die gesamte Psychologie", volume 73, part 3/4). The book also contains a summary by Anschütz on the status of synaesthesia research (Zur Typologie und Theorie des "Farbenhörens").
FTF vol. III was published 1931. It gives a comprehensive documentation of the 2nd congress held in Hamburg from 1st to 5th October 1930. This book makes this congress the best known event of all.

Only poor material was published regarding the other congresses: A report with overview and short excerpts of the 1st congress was written by Rolf Grundner (1930) and printed in volume II of FTF.
The 3rd congress took place in 1933. It focused on “Tonfilm, Neue Bühne, Neue Musik” (sound film, contemporary theatre, contemporary music). This event is only documented by an agenda that has been included into FTF II.
Only few authors mention the 4th congress (e.g. Wellek 1954, cited by Jewanski 1996, and Moritz 1993). It was held in Hamburg on Oct. 4. -11. 1936, only dealing with motion picture, referring to the motto “Spitzenleistungen des deutschen und ausländischen Films – Film als Kunst unserer Zeit“. No further documentation is available. Rudolf Gahlbeck, who had contributed synoptic drawings to former “Farbe-Ton”-conferences, designed the announcement poster (reproduced in: Stockfisch 1995).
Extensive exhibitions were an integral part of the first two congresses. An exhibition of drawings (“Niederlegungen”) of synaesthetic experience was added to the 1st congress. It included either material of scientific interest regarding the transformation of tones into colour or works to be assessed as results of artistic approach. Approximately 2000 pictures and other documents were presented, prepared by Paul Dörken (plasticine, approx. 20 works), Eduard Reimpell (approx. 300 works) and others, notably: Hugo Meier-Thur, Max Gehlsen, Heinrich Hein, Franz Bernack, Hans Möller, Rudolf Gahlbeck, Gertrud Eckermann, Christoph Natter, Oskar Rainer and Ferdinand Eckhardt. Works of pupils were added.
The exhibition of the 2nd congress is described as “bedeutend umfangreicher” (considerably more extensive) than that of the first congress, mostly showing new material, including many works made by pupils (FTF III, S. 407). Several thousand pictures were exhibited (Anschütz 1931b). Rudolf Gahlbeck provided 250 works from his classes, Wilhelm Voss around 400 drawings by 8 blind children. Oskar Rainer did not attend because of disagreement with Georg Anschütz (Adam 2002). Rainer felt himself criticized by Anschütz and Mahling (FTF I, 1927) who argued that “Musikalische Graphik” was not purely synaesthetic, but a result of construction. In fact, the work of Anschütz transformed itself over the years from research on what is meant by “genuine Synaesthesia” (the terminus was not used during this time) to a broad approach which included various phenomena like associations, symbols and conscious construction, thus reaching exactly what Rainer had initiated.
An exhibition of the 3rd congress is unspecificly mentioned in the agenda (reprinted in FTF II): “Eine Ausstellung von einschlägigem Material und entsprechenden Schriften befindet sich in der Universität”. The 4th congress was only dealing with movie topics. Therefore it can be assumed that no exhibition was organized.

7. Analysis of published visualisations

7.1. Analysed literature:

This analysis regards all main publications dealing with synaesthesia and including visualisations from 1925 to 1936. Earlier works on colour-music are added:

Anschütz, Georg (* editor):
- Farbe-Ton-Forschungen*. vol.1, 1927
- Farbenhören und Kunstschaffen. 1928
- Das Farbe-Ton-Problem im psychischen Gesamtbereich. 1929
- Die Farbe als seelischer Ausdruck. 1930
- Farbe-Ton-Forschungen*. vol.3, 1931

- Farbe-Ton-Forschungen*. vol.2, 1936

Voss, Wilhelm: Das Farbenhören bei Erblindeten. 1930 & 1936 („Farbe-Ton-Forschungen“, vol.2.)

Rainer, Oskar: Musikalische Graphik. 1925

Alexander Wallace Rimington: Colour Music, The Art of Mobil Colour. 1911

László, Alexander: Die Farblichtmusik. 1925

Adrian Bernhard Klein: Coloured Light - An Art Medium. ^{3}1937

Georg Anschütz has published most works that contain visualisations. Beside the 3 volumes of FTF, other books are taken into account: A separate study dealing with the synaesthesia of Eduard Reimpell includes 80 drawings by himself (Anschütz 1929). Two popular scientific publications were made for the *Pelikan Werke* in Hannover, manufacturer of ink and colours for school purposes (Anschütz 1928, 1930).
The investigation of Wilhelm Voss is the most comprehensive study included into FTF II. It was published separately in 1930, giving an in-depth analysis of visual perception of young persons who had become blind during infancy.
The books of Oskar Rainer and Alexander László were published before the movement of “Farbe-Ton-Forschungen” started. Both books inspired people to engage in colour-tone relations, the first one regarding educational methodology, the second one regarding construction of multi-media events. Both contain coloured visualisations dealing with genuine aspects as well as with associations and artistic constructions, which not always can be separated without doubt.
Studies on colour-music of Alexander Wallace Rimington (1911) and Adrian Bernhard Klein (^{3}1937, ^{1}1911) are added due to their discussions of colour scales (which are printed in colour). Klein furthermore provides reprinted drawings by E.J. Lind (1900) who probably was the first who ever tried to visualise his synaesthetic experience.

7.2. Concept of analysis

For this study, all visualisations are assessed visually. Descriptions of the painter or the editor are not taken into account. This would lead to distortion of the statistics because extend and quality of descriptions spreads widely. In some cases – especially when Anschütz has conducted the investigations – the descriptions are comprehensive and include critical assessment by the painter and information about repeatability of the photisma. In some cases no specific description is available. Therefore, descriptions were disregarded except the title given by the painter and except information about the stimulus.
It is <u>not</u> proven if the test persons really have been genuine synaesthetes or if they are only copying typical synaesthetic forms (basic forms, phosphenes) from paintings prepared by other persons. The result of this study only provides information about elements of genuine synaesthesia, association, symbol etc. used within the visualisations. In some cases the decision is difficult, because the analyser has to identify the association, and this requires a similar association during his own perception. Thus an association is counted only if it is very clear, like a landscape with trees or a

hall with pillars. Some experience with this assessment shows that problems of decision are smaller than expected, causing only a minor influence on the overall statistics.

7.3. Results

The sub-categories of each level given by the model are combined and the total number of visualisations is evaluated to achieve an overview of the relation of images to specific levels of interaction. Fig. 10 shows the results regarding the publications FTF vol. 1 – 3 of Anschütz. The analysis of Reimpell's synaesthesia by Anschütz (1929) was added while it is closely related to his first comprehensive investigations. Those results show a majority of visual attributes typical for genuine synaesthesia. Some inter-modal analogies and very few associative elements are added. All images refer to inter-modal experience. Visualisations of Reimpell appear to be special cases because he added more associative elements and while many images refer to symbols, a phenomenon which cannot be seen in any other documentation given by Anschütz. Within later publications, visualisations of persons without genuine synaesthesia are included, especially works of pupils resulting from school investigations, as initiated by Rainer (1925). This leads to increasing numbers of analogies and associative elements.
Comparison of the total numbers of pictures related to inter-modal connections with the counts of specific levels shows that inter-modal analogies and associations provide additional visual elements. Therefore the total number of elements exceeds the number of images, because many visualisations include elements of various levels of interaction. This overlap should not be understood as simple redundancy, but may be interpreted as increased complexity of coupling, thus adding further dimensions to the processing of signals perceived via a single modality.
More and more artistic and mathematical approaches appear in the 3rd volume of FTF, resulting in a decreased rate of visualisation dealing with genuine cases. The statistics thus displays the tendency of scientists during this period of synaesthesia research to progress from special genuine cases to an overall view of inter-modal phenomena, including common cases. Anschütz (see summary 1936), Wellek (1930) and Argelander (1927) concluded that synaesthesia is a common feature of the human perceptive apparatus. This led to inclusion of common inter-modal levels into scientific hypothesis, but blurred the specific differences to genuine cases. The application of the model described above for analysis thus clarifies the stage of scientific thinking during this important era.
The distribution of visual elements related to different levels of inter-modal correlation is shown in fig. 11 in case of pedagogic research and concepts of colour-music. As mentioned above, pictures of "Musikalische Graphik" published by Rainer show increased contribution of inter-modal analogies and concrete association, as typical for non-genuine approaches. Symbolic connections appear due to specific conceptual formulations. Compared with scientific publications of FTF, the two popular scientific publications by Anschütz (1928, 1930) also show increased associative and analogous elements due to the focus on pedagogic tasks.
The books of "colour music" are based on physical/mathematical correlations, demonstrated by colour scales related to tone properties. László adds two tables with colour related to musical key and chords. While no systematic can be seen there, they are rated to be genuine. The drawings and shapes designed by Matthias Holl for projection on stage during a colour-music performance are rated in the same manner as shapes typical for genuine synaesthesia, while it is impossible to clarify whether they are based on synaesthetic experience or on conscious consideration.

The 3 visualisations found within the book of Klein (^{3}1937) are reprints of Lind's visualisation of coloured letters (Fig.3), coloured voice and chant.
While the feasibility of colour music at the beginning of the 20th century depended on the availability of technical devices, the analysed books of colour music show a focus on techniques, demonstrating specific details of the used equipment. Therefore the rate of synaesthetic visualisations is small regarding the total number of pictures.
The analysed colour-music publications, however, give doubtless examples of conscious approaches that sometimes creep into synaesthetic imagery, often impossible to detect.
A surprising fact is the large number of visualisations published during this time. The analysed books contain 258 pictures of persons ranked as genuine synaesthets, including the blind persons investigated by Voss, who naturally did not paint the visualisations by themselves. 79 pictures are added, prepared by pupils who have not been distinguished as genuine or not. The total number of visualisations counts up to 337, from which Anschütz publishes 218. Pictures dealing with scientific analysis of phenomena and technical devices for colour music are not taken into account for this statistics, but show a relatively high number of 175 images. The large number of published synaesthetic visualisations demonstrates the very great importance that was attached to visual approaches of synaesthetic research. Recently, some visualisations have relatively carefully been included into scientific books on synaesthesia (Cytowic 1989, Emrich et al. 2001, Harrison 2001).
Analysis of the total numbers of visualisations related to specific stimuli shows that the majority is given by acoustic signals (64%), while letters and numbers (11%), other modalities (4%) and special cases (21%) play a secondary role. Most acoustic signals consist of complex parts of musical compositions of the repertoire of 19th century classics and romanticism, added by popular folk songs. Contemporary composers of modern style music are disregarded, e.g. Schönberg and Webern. This fact confirms the tendency of synaesthesia research during this period to be a popular movement of common relevance. Rather few isolated signals like single instrumental sounds have been used. Anschütz, however, tried to systematise his experiments by use of gramophone records and by exactly relating the reported images to musical phrases.
Only few samples are dealing with human voice and animal noise. The examples of colour-graphemic synaesthesia (letters and numbers) were predominantly provided by the blind subjects investigated by Voss.
Stimuli of other modalities are seldom mentioned: pain, heat, touch, smell, taste. Only pain shows 9 examples, all others are represented by max. 2 entries.
Special cases of stimulation are counted separately: Reimpell provided a couple of images related to abstract ideas and the appearance of persons, animals and flowers. A small number of works on abstract ideas is also included into Rainer's publication. Within FTF III, Hošek reports the particular case of music related to architectural design.

8. Conclusion

The upcoming discussion on synaesthesia during the last three decades of the 19th century was characterized by the search on basic principles capable to establish an overall theory. The research focused on extraordinary cases for which various hypothesis where proposed. Eugen Bleuler himself was his best test person of his investigation in 1881, and he included various relatives into his list of test subjects (Bleuler and Lehmann, 1881). Anschütz continued to report test persons with genuine synaesthesia who were able to visualise their sensations by drawing

pictures. While he at first tried to find basic laws for those singular cases, his approach opened more and more to general considerations, including a wide range of phenomena and artistic concepts into his research. Finally, the “Farbe-Ton-Forschungen” became a kind of movement with broad claim, but less precise topic. This can be demonstrated by analysis of the published pictures as well as with view on the increasing lists of issues related to synaesthesia which appear in the later works of Anschütz: *Abriss der Musikästhetik* (1930a), *Zur Typologie und Theorie des „Farbenhörens“* (FTF II, 1936) and *Psychologie / Grundlagen / Ergebnisse und Probleme der Forschung* (1953).

This tendency is in accordance to other German and Austrian scientists who focused on the generally admitted aspects of synaesthesia during the first half of the 20th century. The most important representatives of this approach beside Anschütz are Wallaschek (1930), Argelander (1927), Wellek (1930) and Werner (summarized in 1966). The search for universal principles is also reflected by various works of pupils, initialised by Rainer (“Musikalische Graphik”, 1925) and more and more included into publications by Anschütz.

The contradiction between specific, genuine phenomena and general properties was often ignored and specific phenomena were mixed within each other. On the other hand, an extraordinary number of examples of the visual appearance of synaesthetic experience is provided, showing good accordance with recent phenomenological approaches. The description of stimuli, however, was done without exact physical analysis and therefore shows lack of precision. The accuracy needed can naturally be achieved with the well-developed and refined measurement technology available at the beginning of the 21st century. The early literature on synaesthesia, however, is well appropriate to teach today’s scientists how to take individual experience seriously.

This analysis demonstrates that the situation becomes much more transparent if various strategies of inter-modal correlation, which appear on various levels, are taken into account and parallel processing is considered.

From the recent point of view – with separation of the general aspects described by psychophysics from the specific phenomena given by the newly reanimated research on synaesthesia – the wide-spreading material of the early 20th century may seem confusing. But it offers an excellent data pool for an in-depth review on synaesthesia, which in future may lead to an extended theory, including <u>all</u> phenomena, but with respect to individual experience based on the omnipresent multi-dimensionality of brain functions.

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Synaesthesia meetings/conferences and books with visual approaches (1924 - 1936)

chronological overview

year	congresses / meetings	books: Farbe-Ton-Forschungen	other books with visual approaches
1924			Rainer: *Musikalische Graphik* (preface dated Autumn 1924)
1925			László: *Die Farblichtmusik* (preface dated Summer 1925)
1926	Presentations of the psychological-aesthetic workgroup 1925 - 1927		
1927		FTF I: 1927 (preface dated January 1927)	
	I : 2. - 5. 3. 1927		
1928	Meetings of the psychological-aesthetic scientific group 1927 - 1930		Anschütz: *Farbenhören und Kunstschaffen*
1929			Anschütz: *Das Farbe-Ton-Problem im psychischen Gesamtbereich* (drawings by Eduard Reimpell, preface dated January 1929)
1930			Anschütz: *Die Farbe als seelischer Ausdruck*
	II : 1. - 5. 10. 1930		
1931		FTF III: 1931 (preface dated March 1931)	
1933	**III : 2. - 7. 10. 1933 - *Tonfilm, Neue Bühne, Neue Musik***		
1936		FTF II: 1936 (preface dated December 1935)	
	IV : 4. - 11.10. 1936 - *Spitzenleistungen des deutschen und ausländischen Films - Film als Kunst unserer Zeit*		

FTF: *Farbe-Ton-Forschungen* vol. I-III

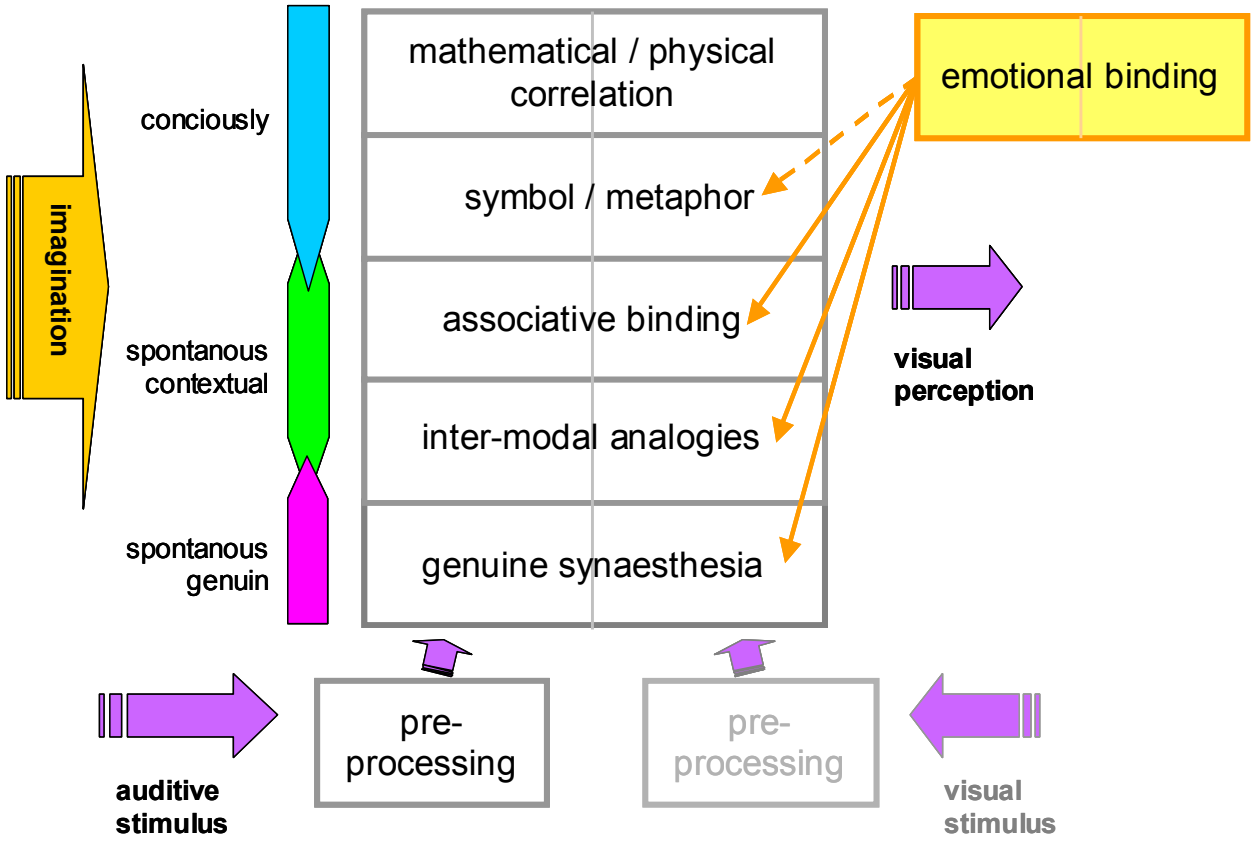
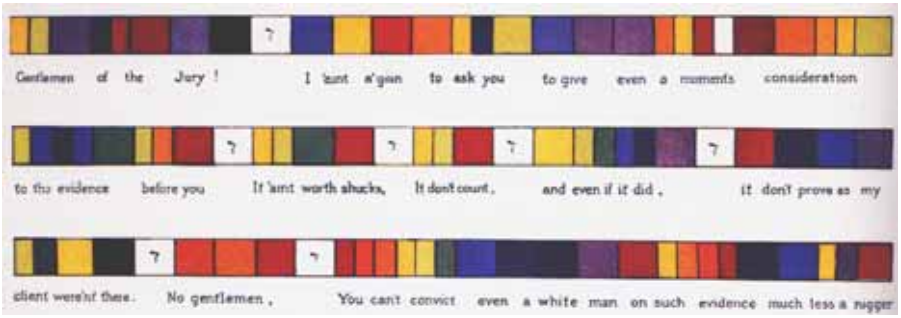


Fig. 1: Model of cross-modal links

Original drawings by Max Gehlsen & Heinrich Hein, documented by Georg Anschütz: *Farbe-Ton-Forschungen I*, Tafel 4 & 18, 1927

Fig. 2: Basic shapes (forms) stimulated by music

Coloured letters, E.J.Lind, 1900:

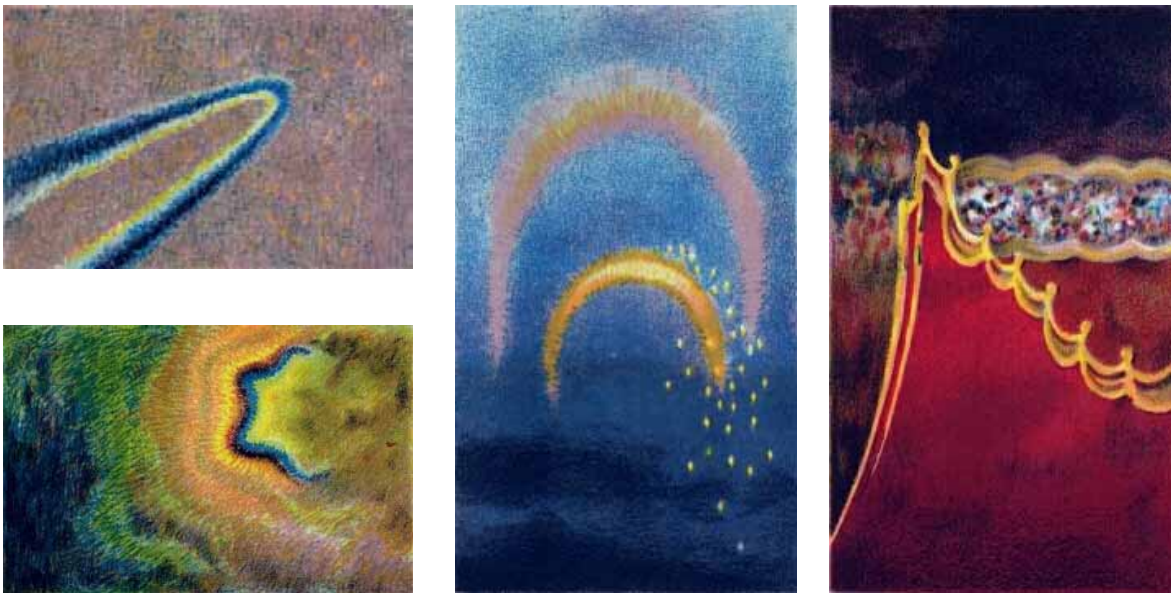


„Lawyers Spoke Stith's Adress to the Jury", 1900, aus: E.G.Lind, *The Music of Color and the Number Seven*

Coloured braille, W. Voss, 1929:

Letters by Louis Braille (1853), as reported by blind subjects, decribed by W. Voss: *Das Farbenhören bei Erblindeten*. Hamburg, 1929

Fig. 3: Visualisation of coloured letter synaesthesia



Original drawings by Max Gehlsen & Heinrich Hein,
documented by Georg Anschütz : *Farbe-Ton-Forschungen I*, Tafel 5 & 19, 1927

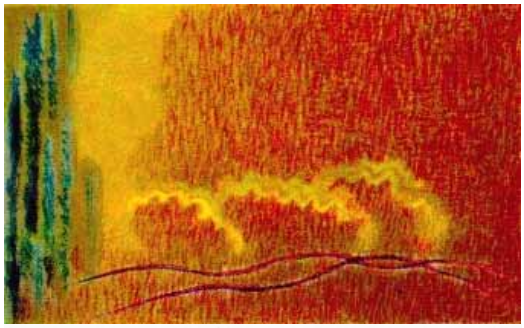
Fig. 4: Phosphene shapes stimulated by music

Folk song: „Es steht ein Baum im Odenwald ...“

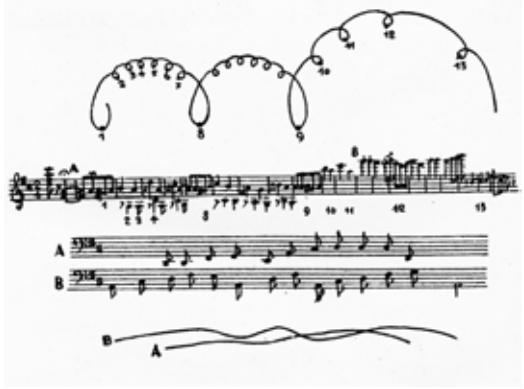
Folk song: „An der Saale hellem Strande ...“

Original drawings by Heinrich Hein,
documented by Georg Anschütz : *Farbe-Ton-Forschungen I*, Tafel 23, 1927

Fig. 5: Development of photisma over time stimulated by music (folksongs)



original drawing by Max Gehlsen, documented by Georg Anschütz: *Farbe-Ton-Forschungen I*, Tafel 2, 1927



musical analysis by Alexander Truslit: Das Element der Bewegung in der Musik und in der Synopsie. In: Anschütz, Georg: *Farbe-Ton-Forschungen III*, 1931

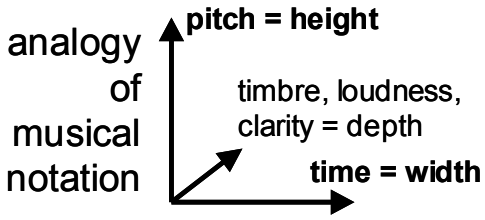
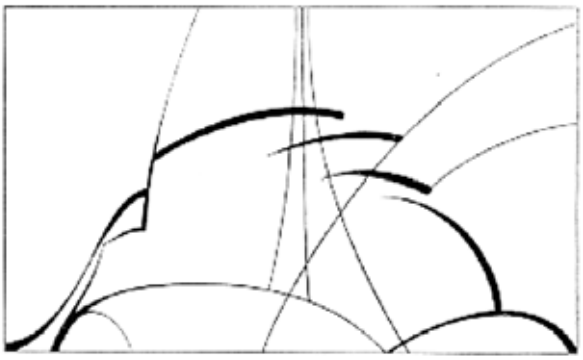


Fig. 6: Analogy to musical notation (“Notationssynästhesie“)



J. S. Bach: Prelude C-major from „Das wohltemperierte Klavier“, drawn by Franz Urbach.

Wagner: Parsifal Vorspiel

Schumann: Symph.D-major

drawn by Hans Kohn

Fig. 7: Examples of musical graphics “Musikalische Graphik” by Oskar Rainer, 1925

"interior"

"landscape"

"landscape"

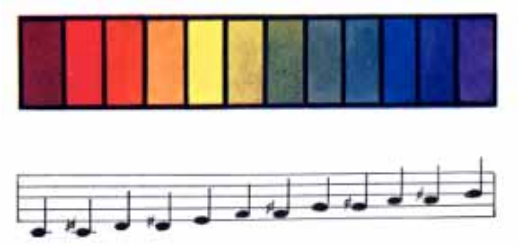
"pavement (coach noise)"

"balls (drum roll)"

originals drawn by August Petersen & H. Hein,
reported by Georg Anschütz: *Farbe-Ton-Forschungen II*, Tafel 1, 1936
and *Farbe-Ton-Forschungen I*, Tafel 20 und 21, 1927

reported by blind subjects, decribed by
W. Voss: *Das Farbenhören bei Erblindeten*. Hamburg, 1929

Fig. 8: Examples of concrete association ("Dingwahrnehmung") induced by auditory stimulation



Chromatic scale (C=red)

Adaption of the physical colour scale to the total tone range

The combination of tones and colours; example by Rimington

Fig. 9: Examples of colour music: relation of pitch and colour, by Rimington, 1911

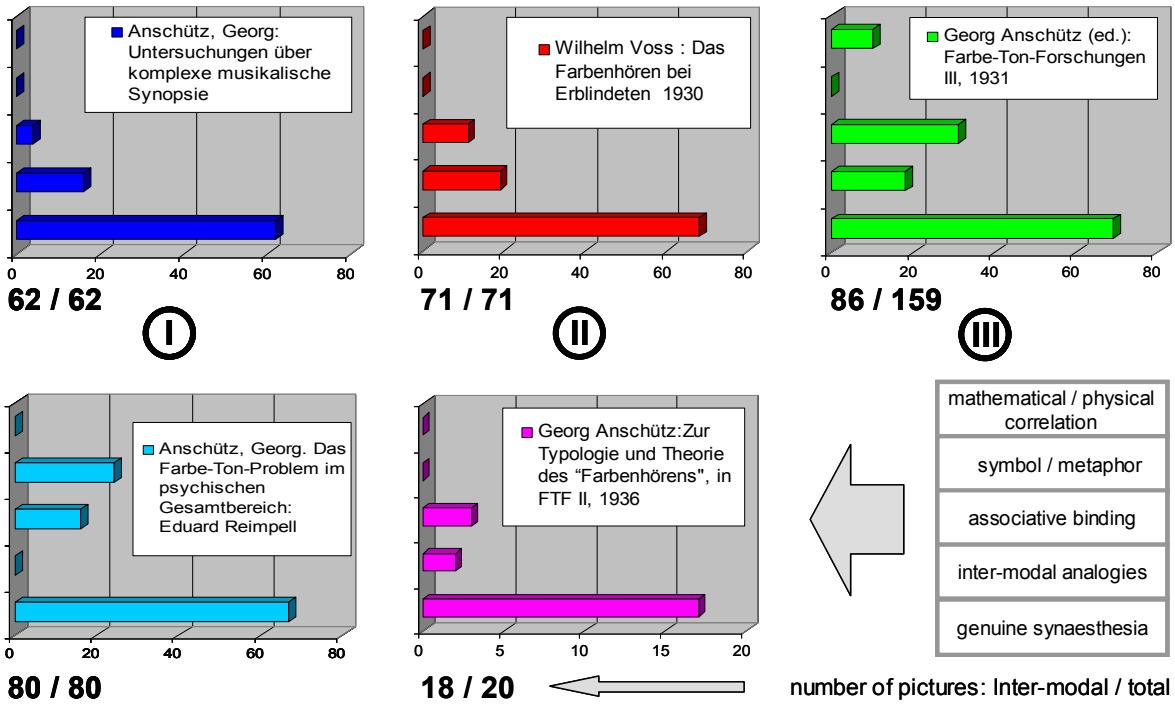


Fig. 10: analysis of publications related to Georg Anschütz: "Farbe-Ton-Forschungen" vol. 1-3

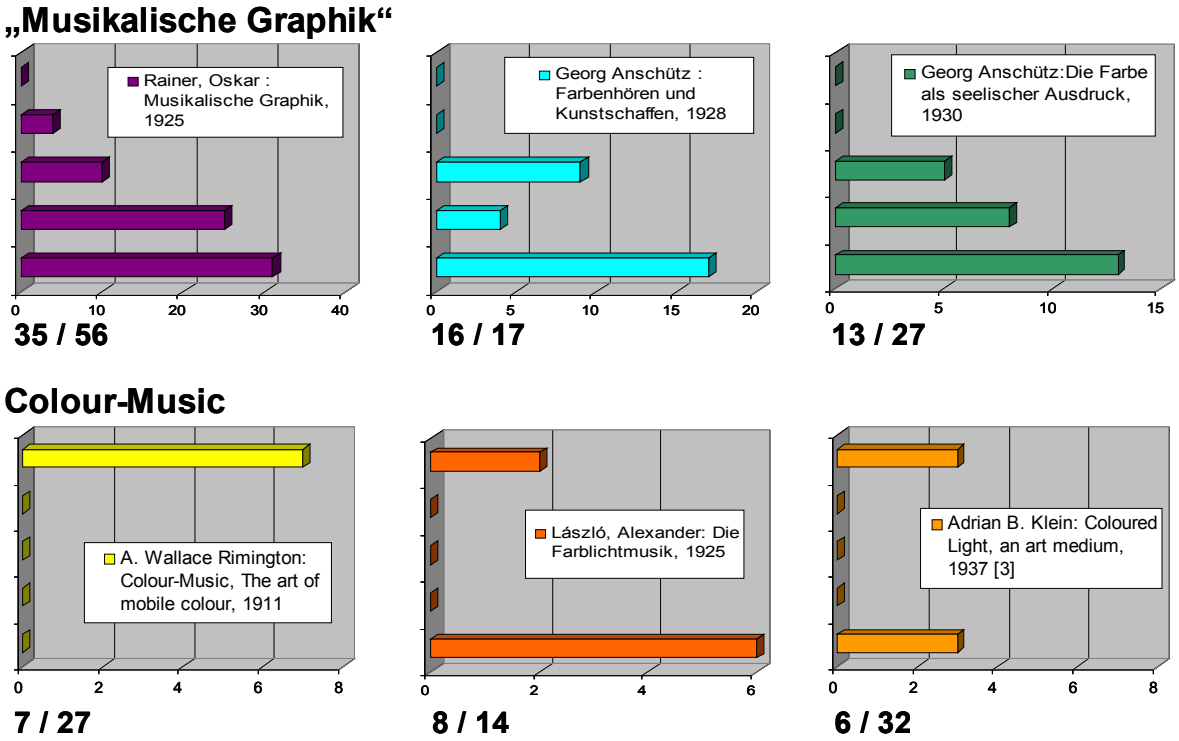


Fig. 11: Analysis of publications related to pedagogics and colour music