

Visualizing auditory Perception: Correlations, Concepts, Synesthesia

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Abstract: Auditory perception refers to cross-sensory attributes. Thus, multi-sensory arrangements for art events as well as for product design must be based on qualitative references between the senses. Conscious concepts have often been used to provide a basis for visualizations of music. The results, however, need to be verified with respect to features which can intuitively be understood by the recipients. Music visualizations by Michal Levy and Johannes Deutsch are appropriate examples for that finding.

Introduction

For at least one century, the question on appropriate visualization of music has gained increasing interest, which still persists.¹ Initially, painters of modernity tried to achieve a musical expression on canvas by use of abstract forms and colors. An essential problem of this way of proceeding is the necessary transformation of temporal, dynamic features of auditory events into static visual depictions. This issue has only partly been resolved by either guiding the observer's eyes via visual structures (e.g. as *Synchromy* by Morgan Russell and Stanton Macdonald-Wright) or enlarging the format in horizontal direction (e.g. as *scroll picture* by Hans Richter). Whereas, during former times, the depiction of music was limited to images of music instruments and of musicians as well as to musical allegories, the early 20th century shows a focus on non-objective forms, which were understood as an analogy to "absolute music". Later on, with the development of movie technology it was possible to align the temporal features of music with a visual stream. The question, however, was not answered as to which visual elements would provide the best correlation to the perception of music. Two principle approaches can be distinguished from each other: exclusive use of non-objective shapes which move in correlation to the music (e.g. as used by Oskar Fischinger) and additions of associative features build on simple forms (e.g. as applied by Charles Blanc-Gatti, "Chromophonie" and Walt Disney, "Fantasia"). Color was seen as the major visual feature (e.g. by

Alexander Wallace Rimington and Alexander László) or limited to decorative aspects (Fischinger). A small, but important topic is the pure visual music, which is intended to provide a substitution of music rather than its complement. In any case, criteria are needed to estimate how appropriate the recipient, the observer-listener will sense the correlation of auditory and visual features.

Conscious concepts versus intuitive features

In principle, an incalculable number of visualizations of music can be generated on the base of computerized analysis of sound. Algorithms generate visual elements, whose features are – partly or as a whole - correlated to selected parameters of the music. Common versions of *media players* are typical applications of this principle. Experience of the users, however, suggests that many of the presented solutions are far away from being comprehensible. Intuitive plausibility can only be gained if the generated visualizations are correlated to the auditory sensations via strategies which are also apparent within the human perceptual system.² A basic model includes three main strategies of intuitive coupling:

- Cross-sensory analogies, including correlations of single sensations - e.g. of their intensity, brightness, sharpness, movement, synchronicity, etc.
- Iconic coupling, based on identification of objects and scenes – e.g. visual forms similar to waves and drops are associated with water splash noise.
- Alignment of symbolic content – e.g. a national anthem associated with a flag.

Various pictures by Paul Klee show the parallelism, but also the interactions between those levels of cross-sensory references, like e.g. *Der Orden vom hohen C* (The order (in German also: medal) of the high C, 1921) and *Alter Klang* (Ancient sound, 1925). With view on cross-sensory analogies, visualizations must refer to the three “dimensions” of sound perception, i.e. to temporal, spectral and spatial attributes.³ Elementary forms play a prominent role in the realm of cross-sensory coupling. The simple, basic visual forms described by synesthetes exhibit great similarities with respect to those forms which are perceived in a half-sleep condition directly before or after sleeping - the *hypnagogic* or *hypnopompic condition*. Moreover, there are also

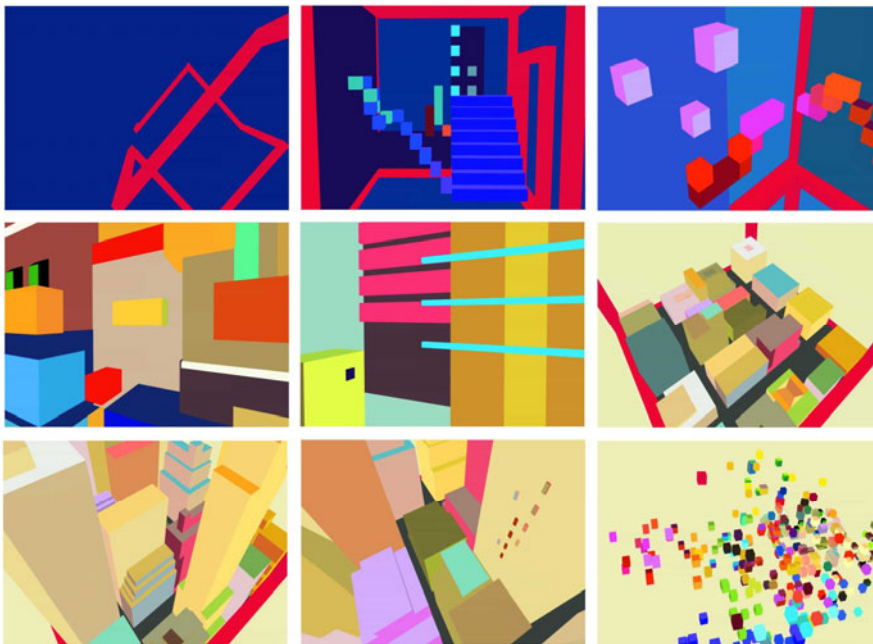
similarities with regard to perceptions during drug-induced hallucinations and subsequent to pathological alterations within the brain. The synesthetic form perceptions thus provide information pertaining to the fundamental forms of perception implemented in the visual system, which are necessary in the construction of complex, visual images. However, they generally do not enter in the consciousness themselves. In those cases in which these basic forms are perceived as luminous structures, they are referred to as *phosphenes*. Those basic image patterns also occur in the case of electric stimulation of the visual nerve. The observed shapes are comparable to elements of ancient arts, such as elementary ornaments of Stone Age ceramics, and even to the drawings of children.⁴ Historically, numerous visualizations of sound and music have been based on elementary forms. These shapes provide the visual “atoms” which are cumulated to figure complex, dynamic structures. The correlated auditory structures, however, are difficult to define. They are given by complete musical sequences, fragments of melodies or harmonies, single notes or by *grains* as the smallest fractions of sound. The ambivalence of complex structures which – in any modality - need to be based on simple forms is a key topic of multi-sensory artwork.

John Coltrane’s Giant Steps – Visualization by Michal Levy

Michal Levy is both a designer and a musician. Like John Coltrane, she also plays saxophone. Born in Israel, she lived in the USA for some years and worked as a design director. Her music animation films *Giant Steps* and *ONE* have very positively been received by the public and were screen in many countries⁵. The music animation *Giant Steps* was created in 2001. It refers to the theme and a shortened improvisational section of the Jazz piece of the same title. The composition by the jazz saxophonist John Coltrane was recorded in 1959 and published January 1960. The animation covers two minutes of music. The visualization is based on simple “building blocks”, which start to successively build up a skyscraper. The first element is the dot on the “i” of “Giant”, which gains three-dimensional quality as a red cube. This cube begins acting as a pen. With its movement correlated to the music, it first

outlines the skyscraper, then generates a staircase by moving upwards. Finally, an urban scenery is build-up inside the house. From that point in time, the red cube changes its function to perform as an eraser, thus eliminating the framework of the house. Only the houses of the urban scenery will remain, finally being dissolved into elementary cubical bricks, which waver around until they vanish. The red cube solely remains, transforming itself back into the original form, the squared dot of the “i”.

The title of the composition *Giant steps* initially refers to modulations within a wide harmonic space, i.e. between keys far away from each other. Taking the title literally, the visualization shows how steps (= stairs) are shaping a staircase of a (giant!) building. Cross-sensory analogies are the base of the animation. As an example, the stairs group synchronous to the music and shape structures similar to a notation - with visual height correlated to tone pitch.



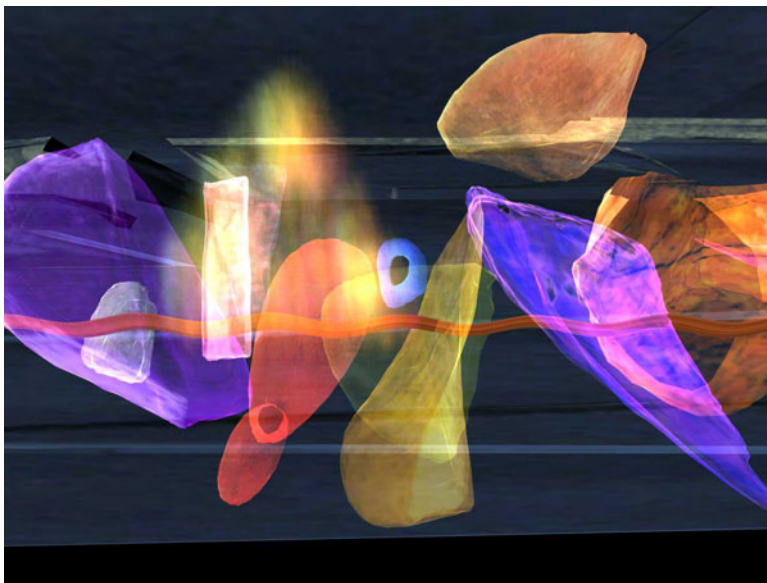
M. Levy: “Giant Steps”, story-board.

Moreover, the elementary forms shape associative (iconic), architectural structures, which are finally deconstructed to simple elements. This proceeding reminds to

the fact that, during perception, each visual structure is assembled from simple elements. Michal Levy reports that her animations are influenced by experience of genuine Synesthesia: “I see music. As I hear it, it appears”.⁶ Her short film appears to be a felicitous synthesis of conscious construction, synesthesia, cross-sensory features and iconic elements, thus well comprehensible to a broad audience.

Gustav Mahler's 2nd Symphony – Visualization by Johannes Deutsch

The 2nd Symphony in C minor, *Resurrection Symphony* by Gustav Mahler provides the music for this elaborated project. It has been composed between 1888 and 1894. The visualization was designed by Johannes Deutsch (Wien, Austria) for live performance with a symphony orchestra⁷. It was realized in cooperation with the *Ars Electronica Futurelab* (Linz, Austria) in 2004 – 2005⁸. The final performance was presented January 1 2006 at the Philharmonie Köln during a celebration of the 50th anniversary of *Westdeutscher Rundfunk*, a German broadcasting cooperation – the orchestra being conducted by Semyon Bychkow. The animation refers to the composition by means of a color concept which supports narrative aspects of the music. Without losing their abstract appearance, the visual elements correlate to the thematic stages of this Symphony: suffering, romanticism, irony, love, doubt and hope. The visualization, however, does not strictly follow the musical content, but unfold a kind of parallel universe. Johannes Deutsch explains: „This work is a matter



of blending together two interpretations: one expressed musically and the other visually.”

Johannes Deutsch: Gustav Mahler, 2nd symphony: screenshot no. 34 taken from the 3rd movement.

Eighteen elementary forms carry the colors and are subject of various form transformations and groupings in space. Those forms were constructed physically and have been scanned into the virtual environment. The whole scenery, however, remains abstract. The only exception is given during the 4th movement (*Urlicht*) where an iconic ambience of romanticism reminds to how the moon appears above a nightly landscape, roughly comparable to surreal sceneries unfolded by the painter

Max Ernst. In contrast to being a predetermined sequence of animation, the presentation is of interactive nature. Sounds of musical instruments directly influence the scenery by initiating synchronous light effects, object pulsation and movement. For that purpose, sensors were attached to a variety of instruments throughout the orchestra. To complete the advanced ambition, the visualization has been realized for 3-dimensional view, which was observed by the auditory using 3-D glasses.

Conclusion

In order to provide intuitive alignment to a composition, concepts of visualization of music need to refer to cross-sensory connections which are frequently used by the perceptual system to generate multi-sensory models of the outside world. Non-objective, elementary forms are often used as objects correlated to music. To gain plausibility, features of those objects must be chosen in alignment to what is happening within the perceived auditory stream. Size, color, position and movement in space are appropriate parameters which can be manipulated. Moreover, iconic features can be used which refer to former experience of daily life and use of media (TV, radio, PC, etc.). Since the human brain is processing numerous data simultaneously within various processing units, coupling features of music visualizations can also be optimized in-parallel. The herein analyzed pieces by Michal Levy and Johannes Deutsch show that sparing, but purposeful use of systematic coupling of features significantly improves perceivability and plausibility of multi-media artwork.

¹ see e.g. "The visual music village": <http://visualmusic.ning.com> (20.3.2010)

² Haverkamp, Michael: Synästhetisches Design - Kreative Produktentwicklung für alle Sinne. München: Carl Hanser Verlag, 2009. English translation under preparation.

³ Haverkamp, Michael: Look at that sound! – Visual aspects of auditory perception. Proc. 3rd International Congress on Synaesthesia, Science and Art. Granada: 2009

⁴ as suggested by Eichmeier, Josef and Höfer, Oskar: Endogene Bildmuster. München: Urban & Schwarzenberg, 1974

⁵ <http://michalevy.com> (20.3.2010)

⁶ at the same place

⁷ published on DVD "Vision Mahler", arthaus music 101420/421, 2007. See also material on <http://www.johannes-deutsch.at> (22.3.2010)

⁸ http://www.aec.at/index_de.php (20.3.2010)