

# Audio-Visual Coupling and Perception of Sound-Scapes

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## Introduction

Recent research shows that inter-modal properties of the human perceptive system have to be included into an integral description of sound-scapes [8]. During the last 15 years, several approaches try to involve various aspects of inter-modal coupling into investigations of sound perception. Most approaches, however, focus on specific phenomena and interpret them from a particular point of view. While different disciplines are involved, each with peculiar methodologies, there is lack of a total description, including all.

## Strategies of inter-modal coupling

A simple model was introduced by the author in order to describe various strategies of inter-modal coupling. It consists of 5 levels of interaction. The model was initially established to correlate auditory and visual attributes of products within industrial design [6]. Since then it was seen that this classification also helps to understand visualisations of sound objects as well as the inter-individual variability of noise assessment. It is furthermore suitable for analysis and design of multi-media events and multi-media product design. In terms of analysis of a perceived environment, the model provides an important approach for setting up experimental conditions and for description of field parameters. It can be used to describe coupling between all senses, but the correlation of sound and visual perception gives the most important application.

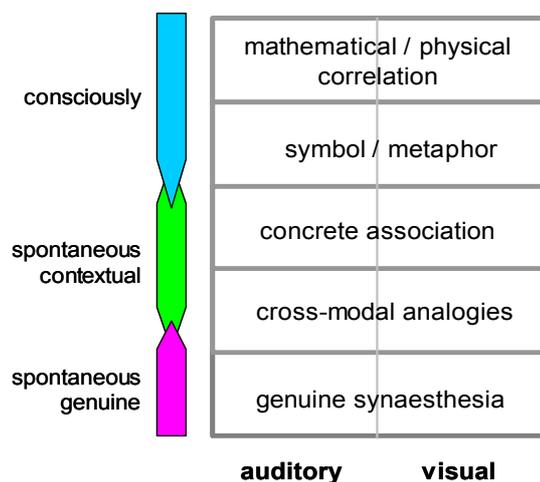


Figure 1: Strategies of inter-modal coupling, in example between auditory and visual sphere

Genuine synaesthesia is a fixed coupling between singular attributes of several senses. It occurs in perception of few people, each with a specific concept or without any noticeable system behind. It is not contextual. While it is strictly individual, no common rules of inter-modal coupling can be derived from those phenomena. But one has to keep in mind that strong individual connections of sensual modes

exist, which in particular cases can influence perception of environmental stimuli (see specific literature, e.g. [4] and [7]).

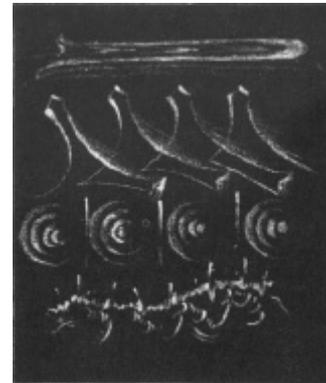


Figure 2: Visualisation of sound perception including cross-modal analogies (i.e. motion) and association (e.g. water drops). From above: car signal horn, wall clock ticking, wall clock striking, water splash (H. Meier-Thur, 1927 [1]).

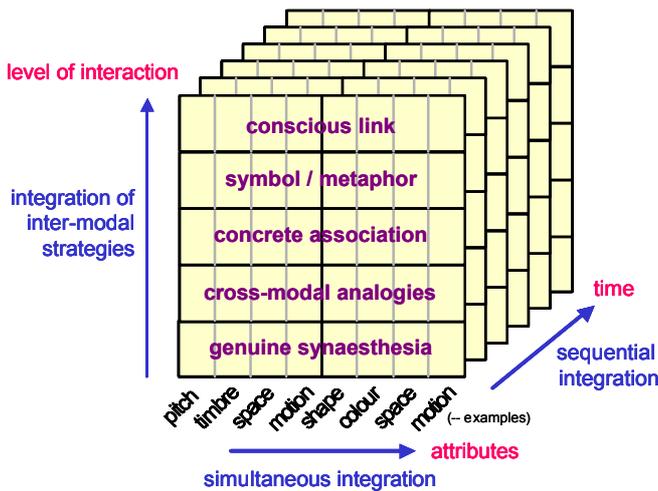
Cross-modal analogies are characterized by coupling of single attributes, like timbre or pitch with brightness or height of visual objects. Werner [9] has shown that several inter-sensual properties exist, which are evident in all sensual modes (e.g. intensity, brightness, roughness). Cross-modal analogies are common, but influenced by contextual parameters. Concrete Association refers to memorized elements. It causes imagination of objects which were formerly perceived together within a specific context. If in example a vehicle noise once appeared while the vehicle has been seen, a visual association can occur with sound perception even if the source is not visible. Onomatopoeic sounds usually enable associative visual imagination. Symbolic interaction is also based on memorized objects. While symbols are socio-cultural constructions, inter-modal coupling on this level must be consequently learned. In example, the connection of danger light and horn sound of an ambulance coach refers to the same meaning. Attributes of concrete association often are added to multi-media symbols in order to accelerate the process of learning (e.g. icons, brand emblems). Audio-visual symbols play an important role in movies to enable easy identification of a preset scene [5]. A special case of symbols are cross-modal metaphors, which are often used during sessions of subjective sound assessment. The upper box of fig.1 summarizes consciously constructed links: Mathematical/physical correlations of sound and light are often used in arts and are subject to various scientific approaches. Especially sound pitch and frequency of visible light have been compared (e.g. as *colour music*, as described in [7]) - an intuitive connection of both, however, does not exist.

## Rules of coupling

The various strategies of inter-modal coupling have been intensively discussed in the past, while theories focusing on only one of them largely appeared to be contradictory to each other. The arisen confusion can be dissolved if the *principle of parallel-processing* is considered: Any correlation at each level of interaction gains a result that initially is independent from other levels. Thus, results can be contradictory or parallel, and results can be consciously assessed, combined or discarded.

## Integration of inter-modal strategies

With view on the tendency of the cognitive system to shape a close *Gestalt* of a multi-modal environment, it can be hypothesized that a "best fit" of all strategies is aspired. A complete model of inter-sensual integration consists of 3 dimensions: integration over time, integration of modal attributes (sequential and simultaneous integration; Bregman [3]) and integration of results of inter-modal strategies (fig. 3). The term *integration* can also include *segregation* of objects. Inter-modal coupling can additionally refer to sequential integration, e.g. if visual and auditory objects correlate via the *principle of common fate*.

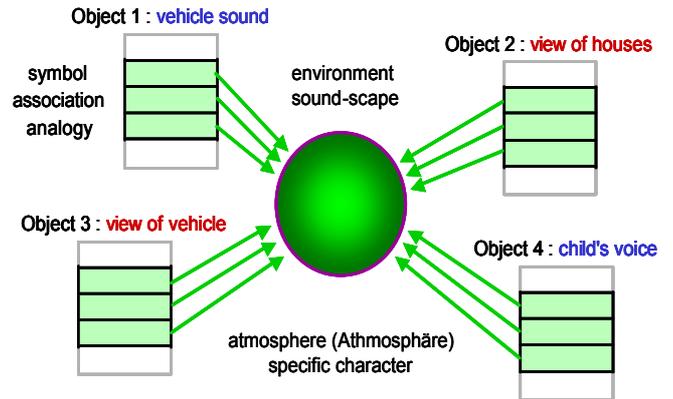


**Figure 3:** Audio-visual model including 3 dimensions of integration, with examples of modal attributes

## Analysis of multi-modal environments

The perceptual identification of sound-scapes is based on intuitive coupling of sensual objects (percepts). Therefore the strategies of cross-modal analogy, association and symbols are of main interest for analysis and design of multi-modal environments. It is evident that other senses are to be considered even if sound-scapes with their primary auditory nature shall be assessed [8]. According to Böhme [2], a main attribute of a perceived environment is its *atmosphere*, defined by a specific *character*. Thus, an important criterion of assessment of a single object regarding a multi-modal context is its match to the characteristic properties of the environmental atmosphere. Each object is characterized by its *coupling features*, which can base on analogy, association and/or symbolic meaning. The grade of

compliance of the coupling features with the overall features of the atmosphere is a main parameter which must be taken into account if a single object has to be assessed regarding a complex environment (fig. 4).



**Figure 4:** coupling features determine the relation of single objects (auditory, visual ... percepts) to the environment

## Conclusion and Prospect

The ability of specific objects (percepts) to fit into a perceived environment can be described by 3 categories of coupling features: cross-modal analogies, concrete association and symbolic attributes. Various observations indicate that the *grade of compliance* of single objects to the environment strongly influences their noticeability and annoyance. Further approaches shall more precisely define variables influencing the grade of compliance with view on the parallel processing at various levels of interaction and on the 3 dimensions of multimodal integration, as established within this paper.

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