EMOTION AND MUSIC IN NARRATIVE FILMS: A NEUROSCIENTIFIC PERSPECTIVE

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The men who make our movies are well aware of [...] how much the score helps to "warm up" the action of the picture, to heighten the emotional impact [...]. They know that a good melody will move an audience when the words or the acting don't succeed.

Kurt Weill, 1946

While writing these sentences the composer Weill remained skeptical about the working process and the pressure put on the composers in the film industry (Weill, 1946), but at the same time he admired the knowledge and the work of the composers in developing and integrating an audio-visual composition. This chapter will explore our recent knowledge of how (film) music modulates affective responses to films and the neural basis of these. A theoretical starting point is the question of the relationship between visual images and music in audiovisual communication of emotions.

Introduction

The extent to which the proposition holds that sound and music properties are subordinate to visual aspects of film remains open to question. Although the development of synchronized sound-film opened the possibility for a composition of visual and sound images into an audio-visual unity, film makers and theorists have mainly relied on the idea that sound helps to interpret the visual narrative, but the visual modality dominates in the reception of narrative structures (see Vitouch, 2001). In contrast, early Russian film director Sergei Eisenstein revealed, while experimenting with a montage of audio and visual aspects of film, that the “two film pieces, of any kind, placed together, inevitably combine into a new concept, a new quality, arising out of that juxtaposition“ (Eisenstein, 1947). Combining visual aspects and sound should according to Eisenstein lead to a common examination of audio-visual montages as unified entities that together modulate the perception and the feelings of the spectators. So what actually is the relationship between visual and sound images, and in particular between visual scenes and their underlying film music? Does one dominate the other in the perception of audio-visual narratives? And what can psychological and neuroscientific research tell us about the relationship?

Cognitive film theory and visual dominance

Over the past 25 years, cognitive film theory has been a dominant theoretical line in film analysis. It focuses on the narrative potential of feature films, examining the formal strategies by which feature films communicate plots. One of the central theoretical assumptions of cognitive film theory states that the essential structure of cinematic narration is the temporal distribution of plot relevant cues (Bordwell, 1985). This theoretical approach led to the understanding that the perception of temporal coherence as well as temporal progress is shaped by the visual perception of continuity. Accordingly, the temporal unfolding of cinematic narration has been equated with continuity editing, i.e. the maintaining of movement directions over a series of shots. Only in relation to this temporal structure, all features of the audiovisual image (e.g. dialogue, facial expression, close ups or sound events) serve as cues within the respective plot constellation.

Therefore, film analysis for a long time examined the different modalities separately, always starting with the visual features like cut or camera angles, followed by an analysis of sound features and film music (Lissa, 1965). On the other hand, film theory includes several theoretical approaches that do not separate visual and sound features in regard to cinematic experience in general or the aesthetic organization of space, time or movement in particular (Deleuze 1985; Eisenstein 1947; Münsterberg, 1916/1996; also Kappelhoff, 2004). In this context Chion (1994) has provided a theory aiming explicitly at a holistic approach to the audiovisual image. He states that the analytical separation of image and sound is arbitrarily taking into consideration a unifying effect of audiovisual perception called synchresis. This theoretical assumption is supported by experimental studies within the field of psychology that hint at a respective salient feature matching mechanism (e.g. Fujisaki & Nishida, 2007). Nevertheless none of these holistic approaches has yet been elaborated into a model guiding film analytical research.

In film analysis the juxtaposition of the visual and the auditory image is sometimes solved by a common discussion of both aspects regarding the effects film has for the affective and aesthetic responses in the spectator/listener, and regarding an understanding of the dramatic and cinematic narrative (Lepa & Floto, 2004). This is counterintuitive, given that an ideal relationship between visual scenes and music may best be described as a symbiosis (Bullerjahn, 2001; Lipscomb & Kendall, 1994) or a synthesis (Lissa, 1965) of the two. Still, and in contrast to the empirical findings (e.g., Lipscomb & Kendall, 1994), in film analysis the dominance of all visual aspects over music is hardly questioned. Sometimes, this is discussed as being a remainder of silent film making (Lissa, 1965). Scholarly film analysis therefore follows mainly the guidelines of classical film makers, in which the primary goal is the depiction of a visual story, along with textual elements like dialogue or voice-over (Bordwell, 1985; Bordwell & Thompson, 1993; Boltz, 2004).

Within film analytical approaches to the elicitation of emotions, the perspective on film music varies. One of the most influencial concept has been Tan's model of fiction emotions and artefact emotions (Tan, 1996). Adopting Frijda's object- and goal-related understanding of emotions (Frijda, 1986, 1987), Tan concludes that genuine emotional involvement in feature films derives from the spectator's sympathetic alignment with the goals of fictional characters. Thus he identifies dynamic appraisals of plot constellations as the spectator's main source of emotions, calling them fiction emotions. For Tan, formal and aesthetic aspects of the cinematic staging, the mise-en-scène, only evoke emotions as objects of aesthetic appraisals of the film as an artefact, hence calling them artefact emotions.

Considering this, it is obvious that Tan's approach to film and emotions even strengthens the separation of image and sound and the corresponding accentuation of the visual. While film music can still provide a source of plot relevant cues within the various theories of cinematic narration provided by cognitive film studies, the cognitive film studies approach to the cinematic elicitation of emotions mainly reduces film music to an object of emotions of its own that does not interfere with the emotions connected to the process of following an audiovisual narrative. In this regard, Tan's work can be seen as representative, and central works within this line of research adopt his focus on fictional characters as objects of spectator's emotions (Grodal, 1997, 2009; Plantinga 2009).

An alternative analytical perspective on film and emotions has been conceptualized by Smith (2003). His mood cue approach loosens the connection between fictional characters and spectator's emotions. According to Smith, feature films are able to elicit specific emotions across individuals highly varying in dispositions due to an orienting nature of moods. Thus, the redundant perception of emotionally coherent cues (e.g. vocalizations, facial expression, actions, sound events) leads to the emergence of a certain mood, that in return reinforces the perception of cues coherent with that mood. Implicitly questioning the dominance of visual features, this approach offers a film theoretical perspective on how film music can modulate the emotional experience of audiovisual fiction.

On the other hand, it highlights the fact that an empirical approach to the relation of visual and sound processing in feature films is highly dependent on film analytical methods that do not only focus on the spectator's understanding of narratives, but instead aims at cinematic principles of organizing audiovisual perception (Kappelhoff & Müller, 2011). For example, the eMAEX (electronically based media analysis of expressional movement images) system has been developed recently as a holistic analytical tool that allows for exploring the audiovisual shaping of emotion in film and its temporal dynamics (Kappelhoff & Bakels, 2011). The system combines a standardized approach to film analysis with a web-based infrastructure that aims at the systematic management of audio-visual data, analytical data and multi-media publishing (see Fig.1).

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On the relationship between visual and auditory information

On a theoretical level, visual dominance is discussed to be based in psychological principles of an attention and processing primacy of visual aspects. In psychology, for example, a juxtaposition of visual and auditory processing has been observed to modulate lower level attentional processes, whereas interactions of both are discussed to occur at higher order, meaning related cognitive processing. On the basis of experimental data Posner, Nissen and Klein (1976) proposed that visual dominance arises from the weak capability of the visual system to both alert and sustain attention. Humans are very visual animals in that our thinking, but also our expressions mainly rely on the visual modality. Accordingly, a visual dominance is usually the case in everyday life. This dominance of visual details to capture attention may therefore result in an overall perception and memory advantage for visual stimuli (Posner et al., 1976). Similarly, the McGurk effect shows that this visual dominance is also evident in the processing of bimodal audio-visual stimuli (McGurk & McDonald, 1976). McGurk and McDonald (1976) observed that the perception of faces in movement modulates speech perception dramatically. In the case that auditory and visual information do not match the perception of such articulation can even change what we hear.

A discrimination between the effects of visual and auditory processing is further supported by longstanding theories of working memory (Baddeley& Hitch, 1974; Baddeley, 2003) that distinguish between a visual-spatial and an auditory verbal subsystem specialized for the respective type of input modality. This model of working memory has had huge influence in psychology, and it may have led to a further substantiation of the existence of a visual dominance in processing and the acceptance of this in film theorists. However, the theory itself has been recently challenged by newer proposals of multi-sensory working memories that do not over-stress the separation of the two processing streams (e.g. Cowan, 1999). Accordingly, for example, Baddeley introduced an episodic buffer in his model (Baddeley, 2000; 2003) as a multi-sensory hub that integrates representations from the subsystems and operates as a global modality-independent work space with close connections to long term memory.

More recent developments have placed the verbal subsystem closer to auditory- and motor-based processing (Hickok & Poeppel, 2000; 2003). Hickok and Poeppel (2003) propose a dorsal (lat.:*'toward the back'*, i.e., superior) auditory processing stream, which in a manner analogous to that of the dorsal visual processing stream is responsible for auditory-motor integration. The authors list music abilities as one major function of stream. Accordingly, this model of speech perception and related language functions was supported by a funtional neuroimaging study that revealed common brain activations for music and language (Hickok, Buchsbaum, Humphries & Muftuler, 2003, also Koelsch, 2011). The authors showed that speech and music, or in particular working memory for speech and music, share highly overlapping neural bases along the left planum temporale, the temporal-parietal boundary area in the brain in posterior regions of the superior temporal sulcus (STS, see Fig. 2).

The notion of a general visual dominance in perception has recently been challenged by more recent examinations of the 'colavita effect' (Colavita, 1974). When presented with simple unimodal auditory (a tone), unimodal visual (a light), or bimodal audio-visual stimuli (light and tone together), participants fail to respond to the auditory stimulus under bimodal conditions where both stimuli have a comparable (subjective) intensity – but also if the tone is twice as loud as the intensity of the light. This effect has often been replicated and has also been extended to more complex stimulation conditions (Sinnet, Spence & Soto-Faraco, 2007). It is therefore taken as strong evidence for the visual dominance. For example, Koppen and Spence (2007) were able to show that in a manner analogous to the Posner explanation above, the colavita effect is partially explained by the exogenous attention capturing qualities of the visual stimuli. In their study, the colavita visual dominance effect was increased when an task-irrelevant and highly discriminable visual but not an auditory prime stimulus preceded the bimodal stimulus (Experiment 4 in Koppen & Spence, 2007). Thus, attention directed to visual modality increased the colavita effect for concurrently presented bimodal stimuli. Hence, visual primes seem to attract attention and to facilitate the processing of the visual aspects of the bimodal stimulus whereas auditory primes do not show such a processing advantage. But it is important to note that recent research also revealed that the 'colavita effect' is modulated by temporo-spatial congruency (see Spence, 2009) and by task effects. For example, Sinnett, Spence and Soto-Faraco (2007) show that when participants are forced to pay attention to the auditory stimulus modality, the visual dominance effect can be diminished. I.e., the visual dominance effect was found to be enhanced when the authors reduced the perceptual load in the visual modality to free up available visual processing resources by simply reducing the number of unimodal visual distractor stimuli. The reverse effect was observed in a reduced auditory perceptual load condition. Again, these result support the assumption of attention capturing capabilities of the visual modality which are expected to be higher with fewer distracting visual stimuli.

A more recent functional neuroimaging study adds another piece to this puzzle: Schmid and colleagues revealed that the visual dominance in their study depended on whether participants focus on the competing modality (Schmid, Büchel & Rose, 2011). Schmid et al. (2011) used neutral photographs and environmental sounds of 2s length in their study. Although visual dominance was expressed in a clear behavioural advantage for visual over auditory object memory, it originated only from conditions in which the attentional focus was located on the competing modality. Differences in brain activation were associated in this study with differences at encoding in auditory (STS) or visual (lateral occipital complex, LOC) processing regions in the brain. Importantly, these activations mirrored the behavioural effect in that auditory processing was susceptible to attention shifts in the case of a competing stimulus modality, but not that 'auditory processing is [...] generally inferior to visual processing' (Schmid, Büchel & Rose, 2011, p. 309). It seems that, in the auditory processing regions, competition for attention was increased due to the parallel processing of a visual object. Accordingly, based on their functional neuroimaging results in a crossmodal auditory-visual processing study, Johnson and Zatorre (2006) propose that crossmodal attentional effects may simply reveal that the processing of one modality is enhanced at the expense of the other. This study revealed that while participants simultaneously processed visual shapes and unknown melodies, selective attention to one modality specifically enhanced activity in the sensory processing region of that modality to the expense of activity in the sensory processing regions of the other modality.

Given the nature of these experiments and the static visual stimuli used therein one has to note that the results are only generalizable for object recognition, a direct transfer to film and film music is speculative at this time (but see the McGurk effect, McGurk & McDonald, 1976). While the research on visual dominance and the theoretical separation of the visual and the auditory processing streams might have substantiated the visual dominance hypothesis, other recent results strengthen the role of multisensory processing in which no one sense dominates.

As explained above, the physiological separation of both modalities in different processing streams has mainly led to the suggestion that an interaction occurs at later meaning-related processing stages.

But an interaction between the visual and auditory modality has been observed at early pre-conscious processing stages too (Meredith & Stein, 1983; Musacchia, Sams, Skoe & Kraus, 2006). Musacchia and colleagues (2006) measured electrophysiological brains stem potentials and revealed that the visual perception of an articulation of a syllable delays the brain stem response to the speech stimulus. The effect occurred as early as 11ms following the onset of the auditory stimulus. Similarly, in cats (Meredith & Stein, 1983) as well as in non-human primates (Wallace, Wilkinson & Stein, 1996), cells in the superior colliculus (see Fig. 3C) have been identified that respond to both modalities, suggesting a true integration of multisensory information at the neural level (Wallace, Wilkinson & Stein, 1996; for a review see Stein & Standford, 2008). The superior colliculus is a midbrain structure which controls changes in orientation and eye movements and seems to act as one of the earliest integration mechanisms that sums activation from the different modalities located within the visual processing pathway but before object recognition takes place (Stein & Standford, 2008). It is notable here that the superior colliculus has also been indicated as implicated in the elicitation of emotions. Via its synaptic connections, the superior colliculus is directly linked to affective core regions in the brain, namely the amygdala and the limbic system (Linke, Lima, Schwegler, Pape, 1999). Thus, the superior colliculus is seen as a pivotal part of the low route that supports fast and unconscious emotion processing (LeDoux, 1996; Morris, Öhmann, Dolan, 1999).

Accordingly, further brain regions have been identified in non-human primates and humans to support multimodal integration (Stein & Standford, 2008, see Fig. 2) including the STS and inferior parietal and ventro-lateral prefrontal cortices. These latter regions should be considered as supporting integration after stimulus identification and are therefore more closely related to semantic processing. The STS, for example, is also discussed to support cognitive empathy, that is the following and understanding of the intentions of others (Frith & Frith, 2003; Hein & Singer, 2008). In sum, neuroscientific evidence exists for both early sensory integration and late meaning-related processing of (simple) audio-visual stimuli, which seems to indicate the existence of a highly interacting and overlapping processing network for complex, multimodal stimuli.

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Besides a visual dominance or a highly interacting processing system of audio-visual information, a third possibility shall be introduced shortly, which will enable us to examine the relationship between film and film music in more detail. As explained above, visual dominance may not hold for every processing situation. Accordingly, Collignon and colleagues have shown that, in emotional contexts, auditory information may be processed primarily (Collignon et al., 2008). In their study, participants were asked to judge the emotionality of short video clips portraying either unimodal fearful or disgusted faces or non-verbal voice sounds or displaying congruent or incongruent bimodal face-sound stimuli. As a second experimental factor, visual images were blurred and noise was added to the sound stimuli. For the evaluation of the bimodal stimuli, a visual dominance was only observable for the unblurred bimodal stimuli. In case of blurred visual information participants favoured the auditory modality! Thus, an auditory dominance was observed for the affective evaluation of difficult-to-process fearful and disgust stimuli.

Similar effects are also known from picture processing, where behavioural and functional neuroimaging data indicate an enhancement of emotional processing of affective pictures due to underlying classical music excerpts of sad and fearful music (e.g. Baumgartner, Lutz, Schmidt & Jäncke, 2006). Correspondingly, brain activations in Baumgartner et al. (2006) were stronger during the combined presentation of affective pictures and music than during the presentation of the pictures alone in regions that are discussed to support affective processing, e.g. amygdala and the hippocampus (see Fig. 3A). The fact that auditory information enhanced the emotional responses contradicts the context-independent assumption of a visual dominance.

Though not directly comparable, a study by Rickard (2004) may be taken as further evidence for this hypothesis: Herein, electrodermal responses that are highly linked to emotional arousal were greater for emotionally intense music compared to emotionally intense film clips. Furthermore, Eldar, Ganor, Admon, Belich, and Hendler (2007) also showed in their functional neuroimaging study that activity changes in response to music in both the amygdala and the hippocampus are considerably stronger when the music is presented simultaneously with film clips (neutral scenes from commercials; positive music was also taken from commercials, and negative music mainly from soundtracks of horror movies). Activity changes in the amygdala and in areas of the ventro-lateral frontal cortex (see Fig. 2) were considerably larger for the combined (film and music) presentation than for the presentation of film clips alone or music alone. In the hippocampus, signal changes were stronger for negative music combined with the film clips. Notably, emotional music on its own did not elicit a differential response in these regions.

Subjective ratings in the study by Eldar et al. (2007) showed that the music plus film conditions were not perceived as significantly more positive or negative than when music was presented alone. Therefore, the functional significance of the increase in signal change (in the amygdala, the hippocampal formation, and the frontal cortex) remains unclear. Interestingly, the findings that the visual system modulates signal changes in the amygdala were corroborated by data showing that simply closing the eyes during listening to fearful music also leads to increased amygdalar activity (Lerner et al., 2009).

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Effects of film music

These interesting results bring us back to the often-discussed proposition that music is a source of emotion in film (Bezdek & Gerrig, 2008; Bullerjahn 2001; Cohen, 2001; Unz, Schwab & Mönch, 2008). Is it possible that sound and music are dominant over visual information in emotional contexts and, therefore, ground the interpretation of the narrative content in emotional circumstances? That is, a main function of film music is seen in the induction or elicitation of emotions (Bullerjahn, 2001, p.188). Bullerjahn examined the basic principles of the effects of film music and revealed its dramatic, epic, structural and persuasive functions (Bullerjahn, 2001). Dramatic function is understood as the mapping of emotions and the strengthening of an affective-aesthetic expression in the respective scenes. The epic or narrative function refers to the supporting of the narrative course by film music, when composers interpret and enhance the intention of the film maker. Its structural function refers to the covering or emphasizing of particular film structures like cuts or single shots or movements. Finally, persuasive functions are refer to all effects of film music where affective-empathic responses and the spectators' identification with a protagonist are enhanced.

It is obvious, that the proportion of these four functions of film music may vary depending on the genre (Bullerjahn, 2001, p. 69). Film music in a melodrama supports functions other than music in a horror movie, e.g., with regard to the identification with a protagonist. The effects of film music on the interpretation of narratives have been investigated by Vitouch (2001). In his study, two different groups of participants watched the opening sequence of Billy Wilder's *The Lost Weekend* with either its original score or a fake score and were afterwards asked to write down possible continuations of the plot. Quantitative analyses revealed that the continuations were systematically biased in their respective emotional content (Vitouch, 2001). Similarly, an earlier study by Bullerjahn, Braun and Güldenring (1994) revealed that different film music elicits distinct judgements of genre membership and emotionality for the very same film scene. Effects of film music can thus be seen as resulting from a combination of the properties of film music and its relations to other film elements, and the expectations and needs of the film spectator (Bullerjahn, 2001). But film music itself may already elicit (genre-)specific emotions based on sound nonlinearities. Biologists Blumenstein, Davitian and Kaye (2010) examined the hypothesis that film music contains specific nonlinear features like noise and frequency transitions analogous to nonlinearities in the vocalization of vertebrates under duress (e.g. in fear screams). An examination of 102 films scores representing four different genres confirmed this hypothesis and revealed a genre-specific use of the different types of nonlinearities in the film music.

The empirical studies that examined the relationship between film music and affective responses mainly supported the idea of dominance of the auditory domain. Accordingly, media psychologists Unz, Schwab, and Mönch (2008) summarize the following effects of film music:

- polarization: genre-specific music moves the emotional perception of a neutral film scene in the emotional sphere of the film music
- additive effect: a paraphrasing audio-visual relation increases the effect of music, both in the film context and in the context of pictures
- auditory dominance: the perceived emotion of a film is more influenced by music than by the behaviour of the protagonists
- greater impact of negative emotions: the emotional effects of aggressive film content are less attenuated by positive film music than positive content by aggressive music

It is suggested that people learn correlations between the frequency and the emotional connotation of musical excerpts and the particular situational narrative content in film (Bezdek & Gerrig, 2008; Boltz, 2004; Bullerjahn, 2001; Vitouch, 2001), and music becomes integrated in memory together with the visual information at a schema level (Cohen, 2005). In her 'Congruence Associationist Model' Cohen (2001) describes how music, film, and speech are processed at four different levels, starting with unimodal processing at the sensory level, and further higher order pre-conscious and conscious integrated audiovisual processing steps that provide a structuring of the multimodal information. The basis of this model lies in the assumption that films generate their dynamic structure through repetition and variations of similar mental processes, such as in music (Cohen, 2005). In support of this assumption, Goldin and colleagues discovered specific time courses of neural responses related to valence ratings in emotional scenes at different emotional qualities (Goldin et al., 2005; see below).

Such correlations seem to affect the spectators' interpretation of the emotionality of the narrative content (Boltz, 2004; Bullerjahn, 2001; Cohen, 2005); and the characters' emotions, whether the music is presented before or after the film (Tan et al., 2007). Since the film scenes themselves are neutral in Tan et al. (2007), the music is most probably the only basis that guides spectators' interpretations of the character's emotion. Accordingly, these effects are observed when emotional music was combined with neutral film clips. This relationship reveals modulatory influences of music upon the cognitive processing of visual scenes (Boltz, 2001). Still, an examination of music effects on the interpretation of film scenes that explicitly addresses affective content is lacking.

A neuroscientific perspective on music, film and film music

Functional neuroimaging and lesion studies have shown that music-evoked emotions can modulate activity in virtually all limbic and paralimbic brain structures, that is, in the core structures responsible the generation of emotions (reviewed in Koelsch, 2010, see Fig. 3A). With regard to the amygdala and the (anterior) hippocampal formation, functional neuroimaging has shown involvement of these structures in emotional responses to music, correlating with (a) music-evoked chills (Blood & Zatorre, 2001), (b) pleasantness/unpleasantness (Koelsch, Fritz, von Cramon, Müller, & Friederici, 2006), (c) joy as well as fear (Eldar et al., 2007), and (d) sadness and fear (Baumgartner et al., 2006).

Moreover, several studies (Blood & Zatorre, 2001; Brown, Martinez, Parsons, 2004; Janata, 2009; Koelsch et al., 2006; Menon & Levitin, 2005; Salimpoor, Benovoy, Larcher, Dagher & Zatorre, 2011) showed that listening to pleasant music activates brain structures implicated in reward and experiences of pleasure, particularly the ventral striatum (including the nucleus accumbens, see Fig. 3B). One of these studies (Menon & Levitin , 2005) reported that activation of the ventral striatum was connected to activity in the ventral tegmental area and the hypothalamus. This suggests that the signal changes observed in the ventral striatum reflect the activity of the neurotransmitter dopamine, as part of the so-called 'reward circuit'. These results are consistent with findings from Salimpoor et al. (2011), showing decreased dopamine binding in the ventral striatum during music-evoked "chills" as evidence of higher levels of endogenous dopamine transmission.

Importantly, activity in the nucleus accumbens correlates with motivation- and reward-related experiences of pleasure; for instance, during the process of obtaining a goal, when an unexpected reachable incentive is encountered, or when individuals are presented with a reward cue. In humans, nucleus accumbens activity has been reported, e.g., for sexual activity, intake of drugs, eating of chocolate, and drinking water when dehydrated (reviewed in Berridge, Robinson & Aldridge, 2009; Nicola, 2007). It is interesting to note that in three of the mentioned studies (Brown et al., 2004; Koelsch et al., 2006; Menon & Levitin, 2005) participants did not report chill responses during music listening, suggesting that dopaminergic pathways including the nucleus accumbens can be activated by music as soon as it is perceived as pleasant (i.e., even in the absence of extreme emotional experiences involving chills).

Neuroscientific research on the interplay of film and emotion is still in its infancy. This should, in particular, be attributed to the fact that only in recent years functional neuroimaging methods were developed for the study of temporally extended stimulus events which has led to the foundation of neurocinematics (Hasson et al., 2008), an interdisciplinary study of cinema. Functional neuroimaging studies examine either blocks of stimulation as a whole or events of shorter durations of milliseconds up to a few seconds. Thus, due to the development of advanced analytical techniques for functional neuroimaging data and due to the fact that actual hardware has increasing computational power, functional neuroimaging studies have started to focus on the neural basis of watching films (see Spiers & Maquire, 2007, for a review of different analytical approaches)

Functional neuroimaging using film stimuli started with early examinations of neural responses under free viewing conditions that revealed functionally specialized processing in cortical and subcortical brain regions (Bartels & Zeki, 2004a, 2004b). Hasson and Malach (2005) found intersubjective correlations of spatial-temporal patterns of activation during the presentation of dynamic film scenes (for similar approaches see Jääskeläinen et al., 2008, Kauppi, Jääskeläinen, Sams, & Tohka, 2010). Wolf, Dziobek, and Heekeren (2010) monitored brain responses of participants while viewing film scenes, and were able to differentiate, by means of an independent component analysis, the neuronal activation patterns in independent, functionally connected components with differing courses of activation. With the use of these two techniques, independent component analysis and intersubject correlations, the parallel activation of independent brain networks during free viewing can be examined (Hasson, Malach & Heeger, 2010). However, these earlier studies did not tell us much about specific relations to features of film and its narrative content.

Of note here are three studies that exemplify this new direction. A first study by Hasson and colleagues correlates cortical activation patterns with emotionally arousing scenes and regionally selective components (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004). In doing so, they were able to show that, for example, the time course of intersubject correlation (ISC) in a cortical face processing region, the fusiform face area, significantly varied depending on whether the stimulus film scene showed faces or not. In contrast to this, the ISC time course in a building-related cortical region, the parahippocampal place, was significantly higher when the film scene depicted places and buildings (Hasson et al., 2004). In the second study, Zacks, Speer, Swallow, and Maley (2010) let their participants identify fine and coarse segments in the event structure of a 10-minute film. Segment boundaries were defined by six types of situation changes in film, e.g. a spatial change was defined as a change in movement of a character or a change in the cameras' point of view (Zacks et al., 2010, see also Zacks et al., 2001). This event segmentation information was used in the following functional neuroimaging study to identify brain responses to such event boundaries. In the third study, Bartels and colleagues examined the neural responses of local and global motion changes that were mainly processed in early visual areas in the brain (Bartels, Zeki, Logothetis, 2008). As such these three studies represent the current state of the art of functional neuroimaging studies of watching films and should be taken as first steps into a deeper examination of (internal) film structures. At the same time, these studies reveal that recent examinations rely on rather quantitative objective structures of films and that we are still quite far from an understanding of the unfolding of the narrative structure and its relation to emotional responses and their probable modulation by film music at a neural level.

Only a few functional neuroimaging studies have examined emotional aspects and still fewer have examined music. The above-mentioned study by Eldar et al. (2007) investigated the interplay of emotional music with neutral film scenes. When either positive (joyful) or negative (fearful) music was superimposed on short neutral film clips of 12 s each, stronger signal changes were observed in the amygdala, and in areas of the ventrolateral frontal cortex, compared to when music or film clips were presented alone. Film clips presented with negative (but not positive) music also elicited higher activations in the anterior hippocampus, a brain region discussed to support memory encoding and retrieval.

The time courses of emotion elicitation with film stimuli were examined by Goldin et al. (2005). In their study, on-line ratings of individual joy and sorrow time courses during the presentation of four short 2 min film clips were included as predictors in their statistical model to predict brain responses. Of interest for the current analysis is that only the two sad film clips contained film music. This approach revealed the expected variations in emotion processing networks including insula and superior temporal regions. Furthermore, superior temporal and amygdala activation significantly covaried with subjective emotion-specific sadness time courses. In a follow-up study, Goldin, McRae, Ramel, and Gross (2008) found evidence for an influence of emotion regulation strategies on separate temporal components of the emotion-elicitation process examined by early, middle, and late components of neural activation during the presentation of emotion eliciting film clips. Thus, strategy-dependent time courses were revealed in limbic regions, the amygdala, and the insula. These functional neuroimaging studies share the idea to use film stimuli to represent naturalistic settings of perception and of emotion induction. As a result it is shown that it is possible to examine emotional reactions in their dynamic course. But what is still missing are studies that examine the role of aesthetic and affective content, their dynamics, and the composition of an arc of tension of film stimuli.

This seems to result from a lack of interest in cognitive psychological research, where previous empirical studies of emotional films usually focused on the use of film material to induce emotions. There are different approaches to reliably induce emotions by the use of film scenes, and meta-analyses indicate that film scenes are one of the most effective methods to induce emotion (Westermann, Spies, Stahl & Hesse, 1996). Gross and Levenson (1995) have created a standardized film stimulus database composed of 16 clips that reliably elicits eight discrete emotions (see also Hewig et al., 2005; Rottenberg, Ray & Gross, 2007). Of these clips only six contained music or tone, the two sadness inducing film clips and the two fear inducing film clips as well as one surprise clip. A further disgust inducing clip used a nursery rhyme as a counterpoint. This low proportion of film music in the database is surprising given the above discussion on the role of film music. And it would be interesting to see whether the use of film music would increase the reliability of emotion induction and whether such effects occur in a genre-specific manner.

The majority of the published physiological studies on the affect of film also focus on emotion induction and the differentiation of physiological response patterns of the different affective conditions (see Christie & Friedman, 2004; Hagemann et al., 1999; Kreibig, Wilhelm, Roth, & Gross, 2007; Palomba, Sarlo, Angrilli, Mini, Stegagno, 2000; Montoya, Campos, Schandry, 2005). Such studies refer to the relevance of physiological responses as a component of emotional reactions, but again tell only a little about the specific characteristics of film that lead to these emotional responses and even less, so far, about the role of music.

Some theoretical notes

While these studies present a clear indication of the appropriateness of film and audiovisual material in emotion induction and the differentiation between specific emotional conditions, yet there are no further behavioral or neuroscientific studies that address specifically the question of the aesthetic and emotional effects of cinematic material, and the dynamics of their narrative processes.

Scherer (2005) introduced a useful model that attempts the currently popular view of emotions as a hierarchy of processes or components involved. Emotions here are characterized as 'as an episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism' (Scherer, 2005, p.697). The five organismic subsystems are information processing, support, executive, action and monitoring and are highly linked to emotional functions and associated emotional components (Scherer, 2005, Table 1). Scherer sets focuses on cognitive appraisal processes, and thus the Scherer model sets the stage for a multimodal examination of emotion production. In particular, emotion in a strict sense is defined by a high 'synchronization of all organismic subsystems, including cognition, during the emotion episode' (Scherer & Zentner, 2001, p. 384).

Moreover, Scherer and Zentner (2001) suggest that, at least in the case of musical emotions (but see Scherer, 1988, for a discussion of other kinds of audiovisual media) empathy may be the relevant precursor for emotional responses to media. In particular, the authors revealed that a main function of music is the production of emotion, rather than its experience. i.e. music does not only trigger emotional experiences itself but it is necessary for producing affective responses via appraisal processes that are related to the music. Appraisal processes, together with motivational aspects and action tendencies (Frijda, 1986) seem an appropriate level of description for an analysis of musical emotions and an analysis of the integration of visual and auditory aspects of film at the level of memory and cognition. But more concrete research is needed. Still the above-mentioned functional neuroimaging studies that revealed a synchronized neural network may already point to a strong presence of emotional processes when viewing dynamic audiovisual film scenes.

Affective and aesthetic responses to film as an aesthetic artefact can be determined within the model of aesthetic appreciation and aesthetic judgements (Leder, Belke, Oeberst & Augustin, 2004). The model evaluates aesthetic judgements and affective-aesthetic responses along five cognitive processing stages: (1) perception, (2) implicit and (3) explicit classification, (4) cognitive mastering, and (5) evaluation. Most importantly, the early mainly automatic processing stages contain novelty checks and familiarity processing that may lead to an initial aesthetic experience, whereas later stages again strengthen the role of (conscious) appraisal processes and evaluations based on meaning-related classifications and cognitive (top-down) mastering to elicit an aesthetic judgement and an aesthetic emotion. Multimodal integration may be incorporated into this model at the stage of implicit memory integration and at the conscious cognitive mastering processing stages, but no particular view on audiovisual aesthetic artefacts is included yet. Both the Scherer and the Leder model, thus, cover the range of possible audiovisual interactions and have their strengths in the description of a parallel and nested processing along a hierarchy of stages or components.

We would like to shift the theoretical focus somewhat more. To explain the elicitation of emotions by film stimuli, one should further consider psychological concepts of empathy and embodiment, because it seems highly plausible that empathic processes are involved in elicitation of emotions by dynamic and figurative stimuli. Affective empathy is the ability to share the feelings of others, together with the cognitive ability to understand the feelings of others and the ability to sympathetically respond to the feelings of others (Decety & Jackson, 2004). Current theories of empathetic processes emphasize a role of frontal and posterior temporal areas (along the posterior superior temporal sulcus into the plenum temporale) and the insula (Decety, 2011, Hein & Singer, 2008). Embodiment theories, on the other hand, support neuroscientific findings, which show that the same neural structures are involved in the representation of one's own body, as are in the perception and representation of other bodies that are perceived. It is assumed that such physical and subjective (experience-based) information facilitates the decoding of emotions and feelings of others (Gallese, 2005). On a cortical level, empathy and embodiment are discussed to rely on simulation processes, like the recruitment of networks that support similar processes as in self-experienced emotions. Thus, internal simulations may be a good starting point for the examination of film-based experiences and the way they are modulated by music. Again, as introduced above, this seems to be a functional role of the posterior temporal regions including the STS, which have been discussed as being both a neural basis of simulation (Hein & Singer, 2008) and a multimodal hub and multimodal convergence zone, in particular for audiovisual integration (Hickok & Pöppel, 2003).

The focus on empathic processes is also an integral part of current film theories (Smith, 2003) that assume a direct link to the aesthetic quality of expression and the emotional reaction of the audience. Common to both, the neophenomenologic film theory (Sobchack, 1992) and the cognitive film theory (Smith, 2003), is the assumption that film scenes impact the audience as a result of their compositions, their montage of auditory and visual aspects, and an emotional arc of tension that develops over time to unfold emotional reactions in the spectators. Given the overlapping neural networks for the processing of multimodal information and simulation processes described above and the overall close relationship between film, film music, and emotion, it will be interesting to see how these film theoretical models are developed further and integrated into neuropsychological theories of empathic responding and the appraisal of emotions - specifically focusing on the narration and the affective responses to film and underlying film music, but it is obvious that further research is needed.

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Figure Captions

Figure 1

Screenshot of the eMAEX system

eMAEX is a standardized approach to film analysis build on a web-based infrastructure to examine the dramaturgical and compositional bases of affective experience. The database, as it was developed for the war film genre, works on three interlinked levels of temporal organization: (1) the film defined as a temporal arrangement of genre-specific pathos scenes, (2) the pathos scene as a temporal dynamic of expressive movement units, (3) these expressive movement units as audiovisual patterns. Depicted is a screenshot of the web-page presenting a clip of an expressive movement unit together with its analytical description.

Mobilization of Emotions in War Films | Genre and Sense of Community | Multimodal Metaphor | Dynamics of Affective Viewer Responses

eMAEX – a standardized method of analyzing qualities of filmic expression

Database "Mobilization of Emotions in War Films"

Films

Categories

Diagrams

Multimedia Publications

Multimedia Studies

LANGUAGES OF EMOTION

Home » Development of Methods - eMAEX-System » Database "Mobilization of Emotions in War Films" » Films » Gung Ho! » Address 1 » Expressive Movement Unit 1

Expressive Movement Unit 1

00:07 00:54

meta data

The address is characterized by static frontality and a geometric fixation on the center of the shot. This gives the clear loud voice and the minimal facial movements maximum effect.
With a fanfare, the title music fades out and the image of a waving American flag blends in. A quick tilt down the mast reveals a static geometric formation: The bottom of the mast is at the center of the shot, it marks the vanishing point at the end of the rows of soldiers which now fill the bottom half of the frame. The light and dark contrasts on the soldiers and the light and dark patterns of the architectural design of the wall in the background mirror one another and replicate the compositional alignment that converges at a fixed point at the center of the frame.

Figure 2

Multisensory regions in the human cortex.

Appropriate location of the multisensory processing regions in the left hemisphere of the human cortex. Multisensory audio-visual regions have been identified in the ventrolateral prefrontal cortex, the inferior parietal cortex and the posterior part of the superior temporal sulcus (STS) extending into the temporo-parietal boundary region.

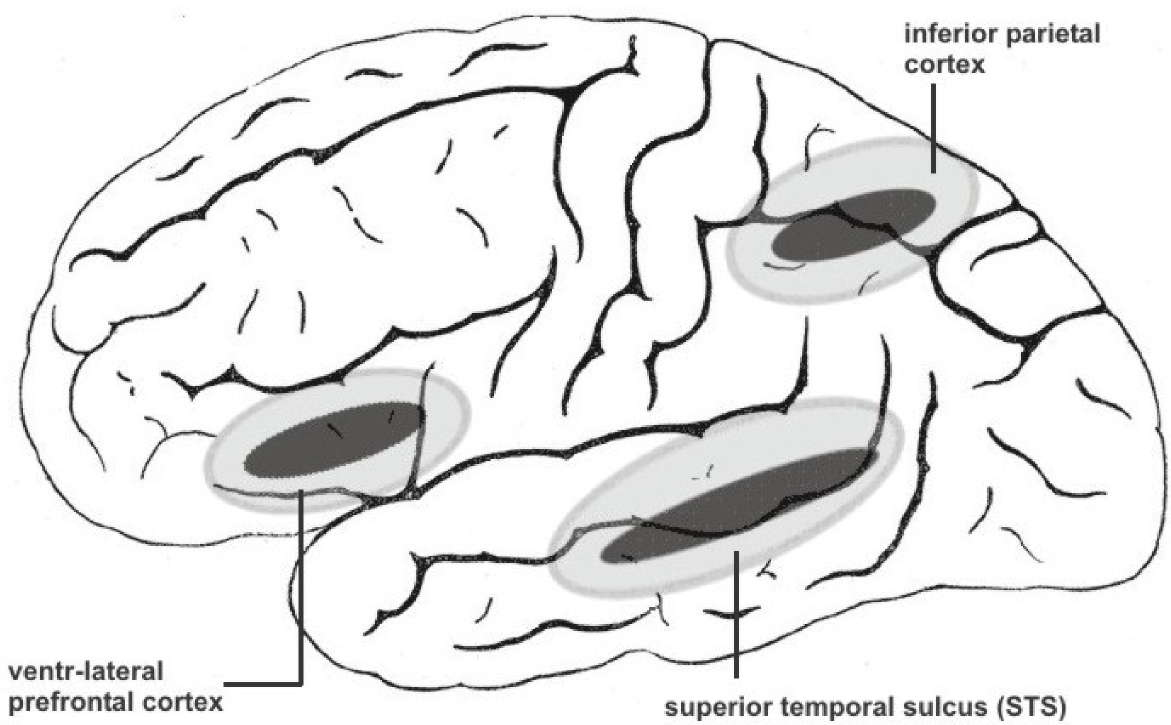

Figure 3

Limbic and paralimbic regions, and the superior colliculus

Illustration of brain regions belonging to the limbic/paralimbic emotion processing system. The diamonds represent music-evoked activity changes in recent functional neuroimaging studies according to Koelsch, 2010. (A) lateral view of the right hemisphere; (B) anterior view; (C) location of the superior colliculus (SC) in the human mid-brain. The SC is a first hub in the visual processing stream and has interconnections to the primary visual areas in the occipital lobe, as well as connections to multisensory processing regions in the ventro-lateral prefrontal cortex, the superior temporal sulcus and the inerferior parietal cortex (depicted in Figure 2). Part A and B are modified, with permission, from Koelsch, 2010, © 2010 Elsevier Ltd.