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# Music Cognition and the Cognitive Psychology of Film Structure

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## Abstract

Early 20th century psychologists drew attention to similarities between mental processes elicited by film and by music. Contemporary film theorists have also noted analogous film and music structures, and contemporary psychologists have used musical metaphors in discussions of film perception and cognition. These psychological parallels have not been explored through experimental research, in part, because of scarce experimental psychological research on film in contrast to the vast amount on music. The present article proposes that music cognition research provides insight into the perception of formal structure in film, taking as support an analysis of the film *The Red Violin*. The analysis reveals similarities between film and music with respect to three kinds of musical structure: central reference (tonality), large-scale form (rondo), and small-scale form (motif). Experiments are proposed to reveal the similarity in the mental processes engaged by music and film for each of the three types of structure, respectively. The application of principles and methods of music cognition to film psychology supports the intuitions of early psychological film theorists. The approach also generalizes to other art forms.

No systematic study has been made of how films may be based on repetitions and variations, but most critics implicitly recognize the importance of these processes. (Bordwell & Thompson, 1999, p. 87)

Like cognitive psychology, the subfield of music cognition has flourished over the last three decades. Recent extensions to the context of film (Cohen, 1994, 2000a) have investigated influences of music on film interpretation (Bolivar, Cohen, & Fentress, 1994; Boltz, 2001; Thompson, Russo, & Sinclair, 1994), film memory (Boltz, 2001; Cohen, 2000b), and visual atten-

tion (Lipscomb, 1999; Marshall & Cohen, 1988). The present article, however, focuses on the similarities in cognitive processes that music and film each evokes rather than on the effects of music on the mental processing of film. Emphasis on similarities of music and film finds precedents in early 20th century experimental psychology and film theory. Curiously, these first music-film analogies faded into obscurity, possibly because no experimental psychology of film was developed for comparison with music. Nonetheless, similarities between music and film processes emerge once again in contemporary experimental psychology and film theory. The present article first reviews these historic and recent analogies between music and film and then examines one film in particular from the perspective of music cognition. It is argued that if past precedents are correct and music and film exploit similar cognitive processes, then recent research in music cognition should facilitate understanding of film cognition.

## EARLY ANALOGIES BETWEEN MUSIC AND FILM IN PSYCHOLOGY AND FILM THEORY

Film, unlike most arts, emerged after the beginning of experimental psychology. The first commercial films were shown around the start of the 20th century, and film entertainment became generally accessible about a decade later. Initially the appeal of film was two-fold: first, as the new phenomenal experience of the motion picture medium, or the *photoplay* as Americans called it, and second, as the content of the film be it story or documentary. Notably, the period just prior to and after the First World War was the only epoch in the Western world during which an audience encountered film first as adults rather than as children. Thus, early psychologists might have had insights about the new film medium that can never again be obtained.

Behaviourism, with its focus on observable behaviour, gained a foothold in experimental psychology at this time. Nevertheless, mental experience still found a following in psychology departments. The rise of motion pictures fostered interest in the stroboscopic effect of apparent motion, fundamental to the illusion of continuity on the screen (Ash, 1995, p. 125). Psychologists might also have addressed film as a new

mental experience, as a new technology for investigating other phenomena, or as a way of communicating knowledge about psychology . . . but few did, possibly because film was often regarded as banal entertainment rather than as an art form (e.g., Hale, 1980, p. 145). By contrast, music was a highly regarded art form, and prior to and during the early part of the Behaviourist Zeitgeist, music was a legitimate area of psychological inquiry.<sup>1</sup> Pioneers of scientific psychology such as Helmholtz, Fechner, Mach, Stumpf, and Wertheimer connected their research and theory to music. Hence, early psychologists, often well-trained in music, were primed for analogies between music and the new motion picture medium.

#### *Early Psychologically Focused Comparisons of Film and Music*

*Hugo Münsterberg.* In 1916, Hugo Münsterberg, a psychology professor at Harvard University, published *The Photoplay: A Psychological Study*, the first book on film psychology. Its content is regarded not only as the psychology of film but also as film theory (Andrew, 1976; Murray, 1988; Stam, 2000). Although required reading for many film classes,<sup>2</sup> it was all but ignored by psychology. The reasons are complex (Cohen, 2000c; Wicclair, 1978). Suffice to say, Münsterberg died eight months after his book's publication. He remains known to psychology primarily for his work in applied and forensic psychology (Hale, 1980; Landy, 1992; Schönplflug, 1994; Spillmann & Spillman, 1993).<sup>3</sup>

Münsterberg took a serious interest in film in 1915

I F. A. Beach, W. V. Bingham, C. S. Myers, C. C. Pratt, & P. E. Vernon contributed to music psychology as well as to other areas (e.g., Beach to comparative; Bingham, Myers, & Pratt to applied, and Vernon to educational psychology). Others, most notably, Carl Seashore, but also Lundin, Revesz, Ruckmish, and Watt, devoted entire careers in psychology to music.

<sup>2</sup> Published film course outlines or descriptions that either name Münsterberg or require reading from *The Photoplay* include: University of Calgary (Film Studies 401.01 Readings in Film Theory), University of Illinois (COMM 502 Seminar in Media Studies), University of California, Irvine (Film Studies 110, Film Theory), New York University (Classical Film Theory H72.2134), Harvard (Visual and Environmental Studies 154br, Frames of Mind: Introduction to Film Theory and Film Analysis Catalog Number 648), New School (Introduction to Film Theory 3926), Chapman University School of Film and Television (Ftv 545 Film theory and criticism), University of Michigan (V414 Film theory and criticism). There is a reissue of *The Photoplay*, Dec. 2001 (Ed. Allan Langdale) by Routledge, and republication in German by J. Schwinitz *Das Lichtspiel: Eine Psychologische Studie [1916] Und andere Schriften zum Kino.* Wien: Synema, 1996.

<sup>3</sup> For example, E. G. Boring (1950, pp. 427-429), Harvard historian of psychology with full access to Münsterberg's archives, fails to mention *The Photoplay* among Münsterberg's contributions.

at 52 years of age (M. Münsterberg, 1922). He believed that film provided psychologists two opportunities: the theoretical opportunity for studying the impact of a new art in the making and the practical opportunity for disseminating mental tests and demonstrations of psychological phenomena to a wide audience. He met members of film production companies such as Vitagraph and Paramount. His appreciation of film was so respected by the industry that he was asked to judge a competition for screenwriters sponsored by a major Boston newspaper.

Of particular interest to the present article, however, are Münsterberg's references to music in *The Photoplay*. Münsterberg was acquainted with music, practicing the cello as a child (Hale, 1980). His writings on aesthetics indicate a rudimentary knowledge of music theory. His introductory textbook for psychology indicates his appreciation of basic psychoacoustics.

In *The Photoplay*, Münsterberg states specifically that although film might seem similar to photography or drama, it is actually more similar to music:

. . . we come nearer to the understanding of its true position in the esthetic world, if we think at the same time of...the art of the musical tones. They have overcome the outer world and the social world entirely, they unfold our inner life, our mental play, with its feelings and emotions, its memories and fancies, in a material which seems exempt from the laws of the world of substance and material, tones which are fluttering and fleeting like our own mental states. (pp. 168-169)

He argued that in moving pictures

. . . the freedom with which the pictures replace one another is to a large degree comparable to the sparkling and streaming of the musical tones. The yielding to the play of the mental energies, to the attention and emotion which is felt in the film pictures, is still more complete in the musical melodies and harmonies in which the tones themselves are merely the expressions of the ideas and feelings and will impulses of the mind. (pp. 185-186)

Thus, perceiving a sequence of shots is like perceiving a musical chord. Münsterberg uses the example of a secretary and her employer. In the first scene, they enjoy an after-work get together in his office; the next scene depicts her parents wondering why she is late; and a third scene reveals the employer's wife anxiously awaiting her husband's return. Münsterberg states, "It is as if we saw one through another, as if three tones blended into one chord" (p. 105).

Authors who have discussed or quoted at length

from *The Photoplay* never mention Münsterberg's attention to the unique relation between film and music, as if it were inconsequential (e.g., Andrew, 1976; Münsterberg, 1922; Nyssonen, 1998; Wicclair, 1978.) Anderson (1996, p. 1) and Hale (1980, p. 145) do use a quotation – the same quotation – of Münsterberg's that refers to music, but without elaboration. However, Münsterberg's references to music, when taken together, are substantial, and they may provide insight into the mental processes underlying film perception.

*Lionel Landry.* Approximately 15 years after Münsterberg's *The Photoplay*, an article by Lionel Landry (1927) appeared on the psychology of cinema in a French psychology journal. Landry makes no reference to Münsterberg's *The Photoplay*, perhaps because, separated by time and geography, he was unaware of it. Like Münsterberg, however, he believed that music is helpful in understanding film from a psychological viewpoint. He stated that not only can analogies be drawn between the two domains, but already there was much known about some aspects of music perception.<sup>4</sup>

Landry described analogies between film and music on four dimensions: velocity, simultaneity, continuity, and intensity. Velocity referred to temporal structure, in particular the acceleration and deceleration that both media could represent. The slowing down in music, referred to as *rallentando*, was compared to slow motion in film. The acceleration in music, referred to as *strette*, could be compared to speeded motion in film.

Simultaneity in music was represented by counterpoint, the juxtaposing of themes in different voices. Landry does not mention harmony as an expression of musical simultaneity, giving further reason to believe that he had not read Münsterberg. For Landry, the notion of simultaneity in film was more lit-

erally represented by the superposition of images, or by split screen techniques.

In discussing continuity in music and film, Landry gives the example of discontinuity created in music through repetition of themes in sonata form. A repetition creates a segment unto itself. In Landry's view, Beethoven overcame the problem of discontinuities by making his music almost completely continuous. Film continuity was created by astute handling of shots, the control of distance and the direction of focus.<sup>5</sup> Finally, the notion of intensity in music and film provided an analogy of changes in amplitude of sound and brightness of light.

*Arnheim.* Following doctoral studies with Gestalt psychologists Wertheimer and Köhler, Rudolph Arnheim, who straddled the disciplines of psychology and aesthetics, wrote a series of essays on film (1933-1938/1957). Cradled in the original Gestalt movement, it was natural for him to refer to organizational principles that applied to different art forms and to both eye and ear. His attention to film as art was unique among the Gestalt psychologists although they studied apparent movement, the illusion upon which film depends, named the *phi phenomena* by Wertheimer (Murray, 1988, p. 284). Less an experimentalist than his teachers, Arnheim considered film at a more global level. He remarked on the resemblance of film to all the arts, including music. He compared the film director to the composer: "It is attractive to the eye to see the same scene first from within and then from without through the glass panel – a pleasure comparable, perhaps, with that experience when a composer presents a theme first in the major and then in the minor key" (p. 50). His essay on motion in film exploits musical terms (pp. 182-187): the "counterpoint of visual motion," "a musically articulate impressive theme of movement," "the great actor is distinguished by a simple, characteristic melody of movement all his own," "musical purity and beauty in the graceful leaps . . . and the heavy stamping . . ." He claimed that increasing realism in film robbed it of its "melodic shape." He discusses montage (editing) using the musical concepts of crescendo and rhythm. Although Arnheim did not explore in depth the music-like aspects of film structure, he clearly appreciated the similarities of music and film structures.

4 Contemporary music psychologists might smile at Landry's belief that much was known about music perception by the 1920s. However, major contributors to the heritage of psychology had investigated music, for example, Helmholtz' (1877/1954) *Sensations of tones*, Mach's (1897) *Analysis of the sensations*, Fechner's (1860/1966) *Elements of psychophysics* and *Vorschule der Aesthetik* (1876), and Stumpf's (1883,1890) two-volume *Tonpsychologie* (for the latter two see Murray, 1988). Less known researchers also made contributions. Whether this work counted as psychology was, however, a matter of perspective. Boring (1950, p. 303) pronounced that only the first of three parts of Helmholtz' *Sensations* was important for psychology while "the other two parts deal with harmony and other musical matters." However, interest in these music issues re-emerged in psychology research in recent decades.

5 This idea predates that of psychological breakpoint in social psychology (Newton, 1973). Recently, the technique of determining psychological breakpoints has been applied to film (Magliano, Miller, & Zwaan, 2001) and music (Deliège, 1987; Frankland & Cohen, 2002; Peretz, 1989).

*Early Film Theorists*

Connections between music and film abounded among film-makers, film theorists, composers and critics in Europe during the silent-film era (Abel, 1988; Andrew, 1976; Mitry, 1963/1997). French film theorists and directors such as Gance and Dulac considered film an art like music: "Cinema should, above all, be (like music) an occasion for the artist to express feelings" (Bordwell & Thompson, 1999, p. 453; parentheses in original text). French impressionist film-makers, influenced by comparisons to music, exploited and explored rhythmic editing (Bordwell & Thompson, 1999, p. 454). Émile Vuillermoz, a distinguished music critic put it directly in 1927: "Thus in the composition of a film we can find the same laws as those governing the composition of a symphony" (in Mitry, 1963/1997, p. 115). In the same spirit, a group of avant-garde German films depicting the "kaleidoscopic movement of urban life" were known as City Symphonies (Sklar, 1993, p. 242), a musical analogy. Whether coincidental or not, between 1929-1939, the Walt Disney Company produced over 70 animations known as Silly Symphonies, a title implying a connection between film and music.

Consider also the eminent Russian director Sergei Eisenstein (1929/1949). He emphasized the similarity in structure of film and music, giving four of five types of montage musical names – metric, rhythmic, tonal, overtone – and employing musical terms (e.g., major, minor, dominant, secondary dominant) to describe other aspects (p. 72-81). He discusses film structure making reference, for example, to J.S. Bach (1939/1949, pp. 152-154). Eisenstein's approach was often literal, as illustrated by a frequently cited passage in *Alexander Nefsky* in which the melodic contour of Prokofiev's score matches the static visual contour of a battlefield scene (Eisenstein, 1942; Sklar, 1993, pp. 227-220).

Notably, analogies between music and film occurred during the era of the silent film. Without sound effects or speech, abstract (music-like) formal properties of film may have been more apparent to theorists and directors. Bywater and Sobschack (1989, pp. 166-168) state that during the silent era, critics and theorists (Münsterberg, Eisenstein, Arnheim, etc.) believed that the exploitation of film structure, through such techniques as editing, led to its artistry. The advent of speech may have detracted attention from the formal aspects of film, directing it toward more literal aspects. Perhaps attention to speech robs processing resources from visual structure, but this is not necessarily the case and is beyond the scope of the present inquiry (cf. Cohen, 2000a).

## RECENT SUGGESTIONS OF SIMILAR MENTAL PROCESSES IN THE PERCEPTION/COGNITION OF MUSIC AND FILM

Little writing about film in experimental psychological appears in recent decades. One contributor, Julian Hochberg (1986), related his expertise in visual psychophysics and often expressed a need for psychological film research (see also Hochberg & Brooks, 1996a, b). The need has been addressed only by rare individuals who typically have a background in both psychology and film (e.g., Anderson, 1996; Cowen, 1988, 1992; Cowen & Lebel, 1998). The void in research may be due to the technical difficulty of controlling film stimuli or the knowledge required to describe the visual (and auditory) stimulus. Moreover, daunting literature on film theory and film style and a huge repository of films may intimidate a film novice contemplating psychological research.

In contrast to the paucity of experimental research in film cognition, research in music cognition has surged ahead, greatly enhanced by technology available on personal computers. Although the technical demands of digital video exceed those of audio, the escalating speed and memory of computers now enable the experimental psychology of film, and it is technically possible for the psychology of film to draw on parallels from the analogous musical field.

Whereas there has been no field of film psychology to explore the ideas of Münsterberg and Landry, film theory forges ahead, producing the content for entire undergraduate and graduate university programs. Due to the scope of present-day film theory, it is not possible here to review it, nor does the present author presume to be able to provide such a review. However, many points do pertain to the present discussion. The main early theories of film, as summarized by Andrew (1976), begin with Münsterberg and pass chronologically to Arnheim, Eisenstein, Mitry, and Metz, among others (see Stam, 2000 for an alternate, extended classification).

Cognitivism is a recent development in film theory. Eminent film studies educator and film theorist, Bordwell (1989; Bordwell & Thompson, 1999, p. 86) has acknowledged its importance to film theory for understanding how the mind processes information and generates expectancies and associations. Psychologist Tan (1996) has related the cognitive emotional theory of Frijda (1986) to the narrative film. Anderson (1996, 1997), who initiated the Institute for Cognitive Studies in Film and Video at the University of Kansas, has applied the viewpoint of ecological optics to film.<sup>6</sup> None of these cognitivist writings forefront music but they refer to music in important ways. The work of Bordwell and Thompson

(1999), Tan (1996), and Anderson (1996) is reviewed in this light.

*Bordwell and Thompson.* From the first to sixth editions of their text, *Film Art: An Introduction*, Bordwell and Thompson (1979, 2001) refer to music in the discussion of film form. They note that thematic repetition is important in both domains. In the simplest case, Theme A returns Episode B; this ABA form is common in music (i.e., ternary form). A specific example is provided by the repetitions of the singing (A), “We’re off to the see the Wizard,” that occur after three distinct episodes (B, C, D) in *The Wizard of Oz* that carry the characters ahead to Oz. (That this is a musical activity is incidental.) In musical terms, the ABACADA form is a rondo (Green, 1980), although Bordwell and Thompson do not use this term. They do, however, refer to *motif* to describe “any significant repeating element in a film” (Bordwell & Thompson, 1979, p. 41; 1999, p. 81). Exposition, development, segmentation, and parallelism are other terms used by Bordwell and Thompson (1999) that serve both music and film. For example, parallelism describes “the process whereby the film cues the spectator to compare two or more distinct elements by highlighting some similarity,” and they hypothesize that “. . . recognition of parallelism provides part of our pleasure of watching a film, much as the echo of rhymes contributes to the power of poetry” (1999, p. 81). Bordwell and Thompson point to the absent systematic study of how film appreciation is based on repetitions and variations, noting that most critics recognize the importance of the process (Bordwell & Thompson, 1979, p. 46; 1999, p. 87). Identifying repetition and variation and their effects are fundamental to music theory, music analysis, and music cognition research. Bordwell (1989, p. 32) specifically acknowledges the potential relevance of “rich studies in music cognition” for film cognitivism, mentioning the work of Lerdahl and Jackendoff (1983) among others.

Despite using musical concepts, Bordwell and Thompson give no special attention to music among the arts. They say that similar aesthetic principles are shared by all the arts, referring to books long associated with psychology, such as Arnheim’s (1974) *Art and Visual Perception* and Leonard Meyer’s (1956) *Emotion and Meaning in Music*, classics that represent issues but

not the methodological advances of the last decades. It is the purpose of the present article to develop the understanding of this potential connection between recent research in music cognition and film.

*Tan.* Most film composers and directors would agree that music is an important source of emotion in film (Cohen, 2001). Tan’s application of Frijda’s psychological emotion theory to film, however, bypasses music. Tan mentions music but only in passing and in a narrow way: “Music serves primarily to highlight those moments that are crucial to the plot. It can illustrate these moments, signal them, or strengthen any moods already inherent to them” (Tan, 1996, p. 55).<sup>7</sup> However, Tan’s other theories about the psychological processes underlying emotion in film draw musical metaphors as seen in the following quotations: “Perhaps we could say that the affect structure is something like the score of the psychological reactions that are timed, meted out, and orchestrated by the filmmaker” (1996, p. 223); “In our representation of matters, concerns are the chords upon which feature films play, through the action of guided fantasy” (1996, p. 236); “The feature film may be seen as a conductor of fantasy, which . . . produces emotions” (1996, p. 236). These references imply that the process by which film and music controls affect and guides fantasy are comparable.

*Anderson.* In *The Reality of Illusion*, Anderson (1996) includes music in his discussion of sound and image. He notes the relevance of Narmour’s (1990) Implication-Realization theory, based on innate (Gestalt-influenced) principles of grouping (similarity, proximity, and common direction). Anderson concludes “His implication-realization theory raises many pertinent issues for a cognitive theory of film style” (p. 88); however, he does not explore these possibilities. It is unclear whether it is Narmour’s theory in particular that Anderson finds intriguing – it has been extremely influential in music cognition research – or whether it is research and theory in music cognition in general. The present article adopts the more general view in connecting music cognition to film, emphasizing that there are many analogies, including Narmour, to be drawn from music cognition to film.

#### *Summary statement*

Reviewing past connections between music and film suggests many potential commonalities in abstract mental processes. Thus, it is worthwhile to examine a

6 Ecological optics is attributed to experimental psychologist J.J. Gibson who directed attention to the primacy of patterns of real-world stimulation – affordances—to which the brain resonates. The pattern of stimulation directly gives rise to perception. For example, an image centred in the frontal plane that continuously and symmetrically expands elicits the perception of impending collision.

7 Several scholars of film music (Cook, 1998; Kalinak, 1992) and film directors (e.g., Tarkovsky, 1986, p. 158) object to this simplistic role attributed to film music.

film from the perspective of music-like structures and music-like mental processes that might underlie its perception. In the next section of this article, therefore, the film *The Red Violin* (Fichman & Girard, 1998) is examined from this viewpoint. However, it is useful to first briefly discuss the field of music cognition.

### *Music Cognition*

Music is a multidimensional and hierarchical stimulus and can be explored from the psychoacoustics of a single tone to the perception of interrelationships between sections of large-scale works. Such topics as sequential memory, perception of rhythm and tonality, aesthetic judgment, and the effects of musical experience are only some of the areas represented by hundreds of articles, journals, and books on music cognition (cf. Deutsch, 1999).

The discipline of music cognition delineates knowledge about musical structure, but it is musical structure as defined by psychologists. For example, consider the concept of tonality. As Arnheim has stated, "...most works of art are organized around a primary center, to which the others are subordinated..." (1992, p. 31, see also Arnheim, 1988). In music, the concept of central reference is often associated with tonality. Tonality may be defined by psychologists as the perceived central reference tone, chord, or key in a piece of music. Various experimental techniques have been developed to identify this perceived central reference, for example, by having listeners sing the most important tone during a musical excerpt (Cohen, 1991), or rate the goodness of fit of individual tones to a whole excerpt (Krumhansl & Toivaniemi, 2001). The results are typically consistent with music theory. A precise definition of tonality, specified as above by operations under certain contexts, should satisfy psychologists and music scientists although perhaps not all music theorists.<sup>8</sup>

Short sequences of tones have often been the focus of music cognition research, but large-scale structures and musical motifs within them have been studied as well (e.g., Cook, 1987, 1993; Krumhansl, 1998; Marvin & Brinkman, 1999). Although there is much research still to be conducted on music issues, new information can be readily derived given both the developed methodologies and related data available. In contrast, there has been almost no research on the perception of film structure. Recall that Bordwell and Thompson (1979, p. 46; 1999, p. 87) state that there has been no systematic study of how film may be based on repetitions and variations. Carroll (1980, p. 3) also noted

this deficiency: "Cinema theorists have typically looked far beyond simple structural relations like synonymy in favor of analyzing complex aesthetic or political relations."<sup>9</sup> The argument here is that if parallels between music and film structure are found, then the same mental processes serving musical structures may also serve the similar film structures. Such an idea has precedents in the Gestalt psychologists' laws of organization (e.g., Ash, 1995, p. 226, 236; Wertheimer, 1938) and in the empirical aesthetics of Daniel Berlyne (1974) who demonstrated in the context of information theory general influences on aesthetic judgments of visual and auditory patterns. The first step in the argument is to illustrate the music-like structures in a film, and so we now begin to examine *The Red Violin* in this light.

### A CASE STUDY OF THE STRUCTURAL COMPONENTS OF THE FILM *THE RED VIOLIN* AND THEIR MUSICAL ANALOGUES

#### *The Red Violin*

That the film *The Red Violin* is about a musical instrument is almost inconsequential to the present argument. The film could have been equally about a red rifle or a blue balloon. However, Rhombus Media Inc., the film company that produced the film, together with film director François Girard, have often explored musical themes, including the acclaimed *Thirty-Two Short Films About Glenn Gould*. In fact, Girard has been quoted as saying "Making film is making music" (Stragow, 1999). So perhaps this company and director tend to imbue their productions with musical structure. The first purpose in the present argument, however, is simply to find a narrative film, any such film, in which the film structures resemble music structures. If one film can be found, perhaps there are others; but if none can be found, then there are no others, and the argument for the similarity in processes of music and film has then surely failed.<sup>10</sup> Examples of generalization to other films will be provided in a later section.

*The Red Violin* tells a fictional story about the fate of a specially crafted violin over a period of 320 years.

9 Carroll (1980) offered an analysis of film structure founded on Chomsky's transformational linguistics but inspired few followers. The linguistically influenced music cognition theory of Lerdahl and Jackendoff (1983) motivated others to test the theory (e.g., Deliège, 1987; Frankland, 1998; Peretz, 1989). Music cognition seldom completely loses sight of the fact that music is an art and for this reason it may provide a better path to film structure than does linguistics.

10 Disney's *Fantasia* (Cook, 1998) or the Canadian National Film Board's Norman McLaren give examples of animations with music structure but what is sought is a film that begins with plot rather than with music.

8 Discussion with Rita Aiello of the Juilliard School of Music about the musicological perspective is acknowledged.

Created in 17th century Italy by eminent violin maker, Nicolo Bussotti, for his expected child, the violin travels a winding path: to a monastery in Austria; via a band of gypsies to a spirited violinist at Oxford; via an oriental servant to 20th century revolutionary China; and from Shanghai to a violin auction in Montreal. The violin possesses a quality that when coupled with an outstanding talent produces inspirational music. The unique character of the violin may be attributed either to its unusual red varnish or to a spell cast on it by a fortune teller.

#### *Tonality and Central Reference*

Pervading a musical work is the structural principle of tonality. As stated earlier, psychologists can agree on an operational definition of tonality. For example, the tonality of a piece might be defined as the key signature assigned by the composer, or the first and last chord of the piece, or the best fit of the distribution of the tones in the piece to a distribution characteristic of prototypical tonal works, and so on. These definitions all imply a central reference tone, one tone that stands out as most important. This is characteristic of most Western European music and some music from other cultures. In the simplest case, finding an analogy to tonality in film, requires finding a central reference. It might be a central character, or theme, to which all other aspects of the presentation relate. Psychological research reveals that sequences of tones that have tonality, or central reference, are memorable (Cohen, 1975, 2000d; Cuddy, Cohen, & Mewhort, 1981). Hence tonality in music is functional, and if a similar property were found in film, information in the film itself might be more easily followed and remembered.

In *The Red Violin*, the violin, though inanimate, has been referred to in film reviews as the main character of the film (e.g., Basora & Chang, 1999; Gilman, 1999; Johnson, 1998; Sragow, 1999; Sterritt, 1999; Sylva, 1998). As illustrated by classic psychological research of Heider and Simmel (1944) on social attribution, humans naturally personify inanimate objects. In their study, audiences who were presented with a short animation judged a large and small triangle and a small circle as bully or victim depending on the motion and size of these objects. Personification is also a common literary device. Thus, it is not far-fetched to suggest that human-like characteristics are attributed to the violin. Almost every aspect of the plot focuses on it. It is the central reference, and, in the analogy to music, it is the keynote, the tonic, simply due to its frequent and lengthy appearances and its presence at significant points in the film (e.g., beginning and end).

Tonal music is comprised of only 12 tones, or pitch-

classes, those from the chromatic scale (i.e., A, A#, B, C, C#, D, D#, E, F, F#, G, G#). They are the *players* in the piece of music. The relative total duration of these tones is fairly consistent for tonal music in a particular key. For example, a piece in the key of C will heavily weight the notes C, E, and G, and lightly weight the accidental (sharp) notes (e.g., A#, C#, D#, F#, G#), leaving a moderate weight on the remaining notes. This durational distribution characterizes that key and only that key. Computer programs can find the key of a musical piece by first determining the total duration of each of the 12 tones in the piece (i.e, total duration of all A's, A#'s, B's,... G#'s) and then comparing the resulting distribution of 12 durations to the prototypical 12-tone duration distribution for each of the 24 major and minor keys (cf. Krumhansl, 1990; Krumhansl & Toivianinen, 2001). The key of the ideal distribution that best matches the test distribution is deemed the best fitting key for the piece. The keynote or tonic has typically the longest duration as compared to the remaining 11 notes.

Considering now the film *The Red Violin*, the greater frequency of appearance of the violin, as compared to the other characters in the film, provides sufficient information to permit the designation of it as the tonic. The appearances of some of the characters are distributed evenly throughout the film, such as Morritz, the contemporary specialist in violins, or Cesca, the 17th century fortuneteller. Most other characters appear during temporally confined episodes of the drama, such as Bussotti in the Italian episode, Kaspar Weiss the child prodigy and his teacher Professor Poussin in the Austrian episode, Nicholas Pope the British violinist and Victoria his mistress in the Oxford episode, or the musicians in the Chinese episode. If appearances are distributed over the entire film, as in the case of the fortuneteller or Morritz, such appearances are short, and if appearances are long during a single episode they are absent from the rest of the film. In contrast, the violin has both features of high frequency of appearance and wide temporal distribution and is the only "character" in the film with these joint features.

Other aspects of the presentation of the violin lend it characteristics of a tonic or keynote. A tonic note in a piece of music serves different functions in different contexts. For example, it can serve different positions in a chord, that is, a collection of tones. As seen in Figure 1(a), the note C is presented in different chords and, as the one common note throughout all chords, acts as a reference. Figure 1(b) represents the role of the tonic C in different chord contexts as they occur in an excerpt from a piece by Bach written in the key of C. Bach's placement of the keynote C in

*Prelude no. 1 in C major, Well-tempered Clavier, bars 19-22*

J. S. Bach

c) *The Red Violin*d) *The Red Violin*

Figure 1. (a) Examples of a note presented in different contexts – the dark note that appears in all bars is the tonic and is also indicated by the arrow (b) bars 19 to 22 from Prelude No. 1 in C-Major of *The Well-Tempered Clavier* by Bach in which the tonic C is presented in the different contexts shown in 1a above (c) the Red Violin as “tonic” presented in the consecutive contexts of different performers at the Austrian monastery (d) the Red Violin as “tonic” presented in the consecutive contexts of different performers and settings en route to England. Film examples used with permission of Rhombus Media, Inc.

these different musical contexts allows the listener to abstract its essence apart from its background. A similar placement of the violin occurs in the Austrian monastery setting as shown in Figure 1(c) when the violin is the photographic focus and violinists change from one to another over several minutes. Later, after the young Kasper Weiss episode in Austria, the violin, again as the central focus, shown in Figure 1(d), remains quasi-stationary while the Gypsy fiddlers fade from one to another. It is as if the director is saying “behold a remarkable violin . . . in a multitude of contexts, its essence remains unchanged regardless of size, age, nationality, natural environment, or era of its performer.” Similarly, a composer directs the listener repeatedly to the keynote, in the context of the tonic chord or other chords, clarifying by the different con-

texts, one common, unchanging central reference tone.

In tonal music, certain relations imply the tonic note. For example, the leading tone, the seventh note of the musical scale, known as *ti* (*doh re me fa so la ti ...doh*) predicts or refers to the tonic, *doh*. When we hear *ti*, we expect *doh*. Similarly, in *The Red Violin*, when the violin is not on the screen, direct (e.g., “the violin”) and indirect (e.g., “if she will give us the pleasure”) verbal references are made to the violin in English, French, German, and Chinese spoken and subtitled words.

Finally, John Corigliano, the composer, developed almost all of the film score from the same thematic material, as represented in the melody first sung by Bussotti’s wife (Figure 2) and this melody also acts as a





actors playing one character in successive shots, Levin & Simons, 2000). The overall structure of the auction refrains is the same and audience members understand that these segments depict different perspectives of an identical time period.

The structure of the film then resembles a musical rondo of the form ABACADAEAF with the refrain A (auction) and episodes B (Italy), C (Austria), D (Oxford), E (China), and F (Montréal). If the structure is similar to a musical rondo then the cognitive processing underlying a rondo could be similarly exploited for the film. The aesthetic pleasure and memory benefits derived from the recognized refrain in both the music and film may be based on the same cognitive processes.<sup>12</sup>

#### *Small-Scale Structure*

The motif in music is the smallest combination of notes to have meaning in the work and its identification is critical to musical analysis on the smaller scale. An obvious example is the *de de de dah* of Beethoven's 5th Symphony, which is presented in many guises throughout the work (e.g., Machlis & Forney, 1999). A classical work may entail numerous motifs of differing levels of prominence. Similarly, repeated motifs appear in *The Red Violin*. Two are discussed below.

*Stairs.* Stairs provide a metaphor for both the escalating value of *The Red Violin* and for the up and downs of its fortune. Examples of stairs and steps are predominant in *The Red Violin*. (see Figure 3).

In an opening scene with Bussotti's wife, there are a few steps, but later there is a long stairway up to her bedroom that is seen in the context of the birthing room. Stairs outside the monastery lead to the room introducing the little prodigy Kaspar Weiss. Stairs lead up to the apartment of his teacher Poussin and to his bedroom in Poussin's home. The Baron's quarters contain a stairway that the Baron ascends during a solicitation from Poussin and descends when he denies Poussin funds, "I have no money for you." A long, luxurious, winding stairway is climbed by Pope's pistol-wielding mistress, when enraged by Pope's wanton behaviour. Stairs lead to the hiding place for the violins in the Chinese musician's home. In Montreal, the elevator, the 20th century version of stairs, plays a role as Morritz makes much of whether his room is on the 27th rather than the 28th floor, and we see him

enter and leave the elevator. Corigliano's music from the opening titles ascends by small musical steps without a change in pitch direction for consecutive spans of 7, 8, and 11 notes (see Figure 3, lower panel). According to Narmour's (1990) implication-realization theory of music, an extended ascending sequence violates natural tendencies of melodic expectation for closure and registral return, yet satisfies principles associated with small musical steps continuing in the same size and direction (Cuddy & Lunney, 1995; Schellenberg, 1996, Thompson, Cuddy, & Plaus, 1997). Even when the ascending melody reverts to a lower tone, it is not clear exactly when the lower tone enters, as illusions of ascending musical staircases can be produced through a clever use of chords and overtones (cf. Shepard, 1964), analogously to Escher's visual staircase illusions.

*Mirrors.* The mirror is a metaphor for the identity of *The Red Violin*. Is the violin with red varnish that has arrived from China the famous Red Violin of Bussotti? Is the so-called Red Violin displayed at the auction a copy? Figure 4 shows a mirror in Bussotti's home that Anna looks into, a reflection of Vienna in the window of the carriage that takes Caspar Weiss to Poussin's home, Caspar Weiss' reflection in the chronoscope that Poussin invented for practicing, a mirror reflecting the image of Nicholas Pope in the rehearsal room outside the Oxford concert hall, and a mirror image of Morritz in his hotel room prior to his decision to return to the auction with the copy. These motifs may heighten the significance of the climactic replacement of the original Red Violin with the copy, in the same way that Beethoven's repeated motif prepares the listener for the triumphant restatements at the end.

#### USING METHODS OF MUSIC PSYCHOLOGY TO STUDY FILM COGNITION

The preceding music-structural analysis of *The Red Violin* with respect to central reference (tonality), large-scale form (rondo), and small-scale form (motif) was consistent with analogies between music and film described in the first section of this article. The demonstration of the analogies raises two psychological considerations. The first is that all three types of structure involve repetition over short or long time bases, be it images of a violin, a sequential refrain, or shots featuring stairs and mirrors. Psychologically, these repetitions are only significant if they are recognized. Repeated appearances of stairs throughout a film are not significant unless the brain registers them, priming the concept of stairs on successive repetitions. Secondly, if the structures identified are indeed music-like, then what is already known or can

<sup>12</sup> The rondo by itself is an oversimplification because another refrain-like structure pervades the film: the fortune teller appears six times, but each time a new fortune card is disclosed. The unfolding as compared to repeating time structure, reduces the similarity to the rondo form.



Figure 4. The mirror motif in *The Red Violin*. Examples used with permission of Rhombus Media, Inc.

readily be found out about music processes should also apply to film.

It is one thing to argue that motifs, refrains, and central references function in film as they do in music. It is quite another to provide evidence that these repetitions have a mental effect. That is what psychological experiments can do. In what follows, several thought experiments are presented to illustrate how methodologies from music cognition research can translate into studies of cognition of film structure.

#### *Central Reference (Tonality)*

Studies of tonality have shown that listeners agree on the keynote of a musical excerpt and that the listeners in turn agree with the composer (Cohen, 1991; Krumhansl, 1990). The keynote is typically the most frequent note and appears at critical times in the piece. The technique known as the probe-tone task was developed by Krumhansl and Shepard (1979) to show that listeners represent a particular hierarchical structure of tones surrounding the representation of the keynote. Can such a hierarchical structure also be shown for a film?

It has been argued that in *The Red Violin*, the violin serves as a keynote, but would audience members agree on this designation and to the nature of its relation to other characters in the film? If musical and film structure are similar with respect to tonality, then an experiment similar to a probe-tone task might reveal a hierarchical relationship of characters in the film. A precedent for examining the semantic space occupied by a character in a film has been provided by Leontiv, Petrov, and Sorkin (1992), who asked participants to rate the degree of similarity of different characters with each of several social stereotypes. Suppose that an experiment is conducted in which, on each trial, a participant is presented with a short excerpt of the film featuring the violin, followed by a clip featuring one of the film characters. The participant is asked to rate on a numeric scale, say 1 to 7, how close the relationship is between the film character and the violin. Agreement on the degree of relatedness of other characters to the main concept, the violin, will reveal a hierarchical relation of characters in the film, just as the probe-tone task reveals the hierarchical relation among tones in a piece of music. Using other characters or concepts as the context to

which all other events or characters are compared might reveal a less systematic pattern of relations and would highlight the greater stability of the violin as a context as compared to other concepts or characters.

Studies of short-term memory have been used in music cognitive research on tonality. Here, sequences of tones that have strong tonality are found to be more memorable than those that have weaker or less coherent tonality (Cohen, 1975, 2000d; Croonen, 1994; Cuddy et al., 1981; Frankland & Cohen, 1996; Krumhansl, 1979; Schmuckler, 1997). Similarly, sections of a film that focus on the metaphorical tonic may be more memorable than those that do not. Exchanging one tone of a sequence for another that alters the original musical structure of a sequence is easily detected, but changes that preserve the structure are difficult to detect (Cohen, 1975; Trainor & Trehub, 1992). The effect of different types of structural alterations can be examined in film. For example, exchanging a viola for a violin or one garment of the performer for another may go unnoticed in a sequence but exchanging a different instrument, say a flute for a violin, or an object, say a shoe for a violin, might be easily detected. Thus, methodologies developed to explore tonality in music can be applied to study tonality-like structure in film.

#### *Large-Scale Structure (Rondo Form)*

Welker (1982) demonstrated that exposure to only variations of a short melodic prototype enabled listeners to draw the melodic contour of the prototype, although they had only heard its variations; in a subsequent recognition test, they also falsely reported having heard the prototype. Using examples from the classical musical repertoire, Pollard-Gott (1983) showed that through repeated exposure, listeners acquire representations of musical themes as conceptual categories. Krumhansl (1998) revealed that listeners' judgments of expected memorability, openness, and amount of emotion correlated with the presence and repetition of musical topics or themes. The materials used by these researchers have been either more complex or less complex than that of rondo form, which continually returns to the same musical theme after excursions elsewhere. Extrapolating from past results, listeners would likely come to recognize the refrain in a rondo, respond emotionally and aesthetically to it, and achieve a sense of closure upon repeated and final refrains. If such effects were found for the musical rondo, we may rightly ask whether the same effects would characterize a film such as *The Red Violin*, which is structured as a rondo.

This issue can be studied experimentally using refrains, for example, from Mozart rondos that would

be extracted, leaving only the episodes and one final refrain. Similar structural editing of *The Red Violin* would extract all scenes of the auction except the final one. Two related experiments would be conducted, one for the music and one for the film. In the music experiment, listeners would be presented with the edited or unedited rondos (different rondos for different listeners, edited or unedited). Their task would be to use a rating scale to judge how well they like the beginning and ending, how well-structured the piece is, and how good the recording is (e.g., evidence of glitches). In the film experiment, some participants would view the original uncut film and others the edited version. They would answer the same questions as the participants in the music experiment. It is hypothesized that the endings of the altered music rondos and the film will be less satisfying than the original versions. Regardless of the specific outcome, similarity in response patterns for the music and film conditions would confirm that musical and film processing engage similar underlying cognitive processes.

#### *Small Scale Structure (Motif)*

At the level of the motif, the question is, does the audience register similarity when presented with objectively synonymous information (e.g., different examples of stairs)? Experiments to provide evidence for the effectiveness of motifs in film or music would necessarily control the number of exposures to exemplars of the motif. In the musical realm, Deliège (2000) varied the number of presentations of a passage by Bach and subsequently asked listeners to judge how sure they were that a motif had or had not been presented. Recognition items were of three types: previously presented, altered, or originating from a portion of the piece that had not been presented. Evidence of encoding the motif was provided by false positive judgments to items that were from the piece but had not been played. Reaction time measures were not obtained, but these might also provide information about the establishment of the motif. Frankland (1998) has collected both types of data in a study that examined the recognition of four-note motifs, after one, two, and three repetitions of the original melody.

Analogous studies could be conducted for film. Instead of repeating the presentation of the film, it might be wiser to create two film versions that vary in the number of presentations of exemplars of the motifs of interest. Such a manipulation of the film is feasible with nonlinear (cut-and-paste) editing available on recent desk-top computers. To give a more concrete example from *The Red Violin*, one condition of the film presentation would remove some examples

of mirrors and retain all examples of stairs, and the other condition would reverse the distribution of exemplars. In the subsequent recognition task, response time for previously seen mirrors and stairs should vary inversely with the number of exemplars in the original presentation, and numbers of false alarms should vary directly with the number of exemplars presented. Such results would be consistent with the view that associative networks are primed by repeated examples of a concept.

In summary, the above thought experiments reveal the feasibility of studies of film structure cognition that are modeled on research in music cognition. For each of three kinds of structure, music research paradigms could be adapted to a film situation such that comparisons in the outcomes between the music and film results would indicate similarities in mental mechanisms supporting the respective structural representations.

#### CONCLUSION: BEYOND *THE RED VIOLIN*

The present article has reviewed references to similarities between music and film that emerged at the beginning and end of the 20th century. Prior to the talking picture, Münsterberg and Landry, writing in the context of experimental psychology, believed that mental processes underlying music provided a good model for understanding many aspects of film perception. In more recent years, film theorists and psychologists have also created analogies, both knowingly and unknowingly through the use of metaphors. The application of musical analysis to *The Red Violin* revealed examples of central reference, large-scale (rondo), and small-scale (motif) form. Our psychological ancestors would not be surprised by these results. However, progress in music cognition research since their time allows us to suggest experiments that would provide concrete evidence of similar mental processes. Thought experiments revealed the feasibility of studies of film structure cognition that are modeled on past research in music cognition.

Whereas the focus here has been on *The Red Violin*, countless other films can provide examples. Just as the title of a musical piece will identify the tonic (e.g., *Minuet in G, C-minor Symphony*), so the film title often identifies the central focus, be it *The Titanic*, *The English Patient*, or *Citizen Kane*. The film “keynote” is often evident regardless, for example, Scarlet O’Hara in *Gone with the Wind*, Dorothy in the *Wizard of Oz*, and Lester in *American Beauty*. Schlemmer (2000) in an analysis of Hitchcock’s (1936) *The Man Who Knew Too Much*, suggests that in some contexts film music too can become the main character. Whatever its nature, the central focus of a film is typically depicted in vari-

ous contexts throughout the film, so that by the end the audience knows its essence in the same way that the listener “knows” the tonic by the end of the piece of music.

Considering large-scale analysis, refrains characterize these and other films. In *The English Patient*, there is a continual refrain of the patient dying in bed. In Krzysztof Kieslowski’s (1993) *Blue* from the *Three Colour Trilogy*, the female protagonist swims across the pool several times during the film meeting up each time with a different character who moves the plot forward. In *Gone with the Wind*, the theme of home (Tara) recurs. Imagined and actualized plans, such as carried out by the doubting husband in *Unfaithfully Yours*, provide another class of examples.

Motifs are common in many films. In *American Beauty*, red roses symbolize beauty, but the red calls beauty into question when it colours the door of Lester’s house, his dream Camaro, and finally his blood. As in *The Red Violin*, in *American Beauty*, reflections (here as video images) provide a repeated reminder of the search for truth and reality. Stairs are recurrent symbols in *Gone with the Wind* as in *The Red Violin*, and the colours scarlet and green repeat in costumes (green curtains that Scarlet makes into a dress), landscapes/skies, and in words themselves (protagonist *Scarlet* claims she is *green* with envy).

Films vary in the degree to which the proposed analysis is applicable. But many films whose forms have been thoughtfully designed and depart from a uniform linear structure and documentary realism may submit well to this analysis. This type of musical analysis does not apply to all music either, but to music that is often complex, redundant, lengthy, memorable, and aesthetically pleasing. Whereas the present article has focused on a musicological approach to film cognition, other temporal art forms (e.g., poetry, literature, choreography) might also submit to this type of analysis and cognitive research. None of these other arts has yet an experimental psychology as developed as has music. A parallel-channel framework for the mental representation of film and film music put forward by Cohen (2001, in press) emphasizes that the sensory origin of multimedia information becomes less relevant at higher levels of analysis. Thus, what cognitive research reveals about higher-order structure in one domain of art will inform understanding of the others. More research in cognitive film psychology would therefore benefit film but also the field of music cognition and the cognition of other arts. To assist the endeavour, scholarship in music provides theories and systems for symbolizing repetition and variation in time (Cook, 1998), and scholarship in music cognition provides additional

theories and experimental techniques for testing theoretical ideas. Thus some day, perhaps it will be written that, "guided by research in music cognition, research on film cognition is focusing on the mental processes engaged by repetition and variation in film structure; most critics implicitly recognized the importance of these processes and now it should be possible to demonstrate and understand them in the manner that has been employed in music cognition research."

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## Résumé

Les psychologues du début du XXe siècle se sont penchés sur les similitudes entre les processus mentaux qui interviennent dans la perception filmique et musicale. Les théoriciens du cinéma d'aujourd'hui ont également observé des structures musicales et filmiques comparables et les psychologues contemporains se servent de métaphores musicales pour étoffer leurs thèses sur la cognition et la perception cinématographiques. On explique partiellement le fait que la recherche expérimentale n'ait pas encore cherché à expliquer ces parallèles psychologiques par la rareté des contributions de la psychologie expérimentale dans le domaine du cinéma, par rapport au grand nombre de recherches menées dans le domaine de la musique. Le présent article, en s'appuyant sur une analyse du film « Le Violon rouge », cherche à démontrer que la recherche en cognition musicale est en mesure de donner un aperçu de la perception de la structure formelle au cinéma. L'analyse révèle des similitudes entre le cinéma et la musique en ce qui concerne les trois

catégories de structure musicale : référence centrale (tonalité), grande échelle modale (rondeau) et petite échelle modale (motif). Les expériences présentées révèlent des similitudes sur le plan des processus mentaux qui interviennent lors de la perception filmique et musicale, que l'on observe à chacune des trois catégories de structure musicale. L'application des principes et des méthodes de cognition musicale au domaine de la psychologie du cinéma vont dans le sens des intuitions des tout premiers théoriciens de la psychologie du cinéma. La même approche peut s'appliquer à d'autres formes d'art.

## References

- Abel, R. (1988). *French film theory and criticism. Vol. 1. 1907-1929*. Princeton, NJ: Princeton.
- Anderson, J.D. (1996). *The reality of illusion: An ecological approach to cognitive film theory*. Carbondale, IL: Southern Illinois University Press.
- Anderson, J.D. (1997). Introduction to the symposium on cognitive science and the future of film studies. [Online]. Available: <http://www.gsu.edu/~wwwcom/ccsmi/v3n1p1.htm>, 2-6.
- Andrew, D. (1976). *The major film theories*. New York: Oxford University Press.
- Arnheim, R. (1957). *Film as art*. Berkeley, CA: University of California Press. (Original work published 1933-1938; 8th printing 1971).
- Arnheim, R. (1974). *Art and visual perception*. Berkeley, CA: University of California Press.
- Arnheim, R. (1988). *The power of the center: A study of composition in the visual arts*. Berkeley, CA: University of California Press.
- Arnheim, R. (1992). But is it science? In G.C. Cupchik & J. László (Eds.), *Emerging visions of the aesthetic process* (pp. 27-36). Cambridge, UK: Cambridge University Press.
- Ash, M.G. (1995). *Gestalt psychology in German culture, 1980-1967: Holism and the quest for objectivity*. New York: Cambridge University Press.
- Basora, A.C., & Chang, Y. (1999, June 18). Musical panorama: The Red Violin. [Review of the film *The Red Violin*.] *Newsweek*. Retrieved from the Web October 2000. <http://members.Easyspace.com/knightley/newsweek1990618.html>.
- Berlyne, D. (Ed.) (1974). *Studies in the new experimental aesthetics: Steps toward and objective psychology of aesthetic appreciation*. Washington, DC: Wiley.
- Bolivar, V., Cohen, A.J., & Fentress, J. (1994). Semantic and formal congruency in music and motion pictures: Effects on the interpretation of visual action. *Psychomusicology*, 13, 28-59.
- Boltz, M. (2001). Musical soundtracks as a schematic influence on the cognitive processing of filmed events. *Music Perception*, 18, 427-455.
- Bordwell, D. (1989). A case for cognitivism. *IRIS*, 9, 11-41.

- Bordwell, D., & Thompson, K. (1979). *Film art: An introduction*. New York: McGraw Hill.
- Bordwell, D., & Thompson, K. (1999). *Film art: An introduction*. (International ed., 5th ed.). New York: McGraw Hill.
- Bordwell, D., & Thompson, K. (2001). *Film art: An introduction*. (International ed., 6th ed.). New York: McGraw Hill.
- Boring, E.G. (1950). *A history of experimental psychology* (2nd ed.). New York: Appleton-Century-Crofts
- Bywater, T., & Sobschack, T. (1989). *Introduction to film criticism*. New York: Longman.
- Carroll, J. (1980). *Toward a structural psychology of cinema*. New York: Mouton.
- Cohen, A.J. (1975). Recognition of tone sequences from the Western-European chromatic scale: Tonality, transposition and the pitch set. Doctoral dissertation, Queen's University. *Dissertation Abstracts International*, 1977, 37, 4179B. (Available from National Library, Ottawa, Ontario. Order No. PC26238)
- Cohen, A.J. (1991). Tonality and perception: Musical scales primed by excerpts from the "Well-Tempered Clavier" of J.S. Bach. *Psychological Research*, 53, 305-314.
- Cohen, A.J. (1993). Associationism and musical soundtrack phenomena. *Contemporary Music Review*, 9, 163-178.
- Cohen, A.J. (Ed.). (1994). Special issue on the psychology of film music. *Psychomusicology*, 13.
- Cohen, A.J. (2000a). Film music: Perspectives from cognitive psychology. In J. Buhler, C. Flinn, & D. Neumeyer (Eds.), *Music and cinema* (pp. 360-377). Hanover, NH: Wesleyan University.
- Cohen, A.J. (2000b). Processing of music and film: Independence and integration. Manuscript accepted pending satisfactory revision. *Memory and Cognition*.
- Cohen, A.J. (2000c). Hugo Münsterberg's (1916) "The Photoplay" and the psychology of film and film music. (Abstract) *Canadian Psychology*, 41: 2a, 44.
- Cohen, A.J. (2000d). Development of tonality induction: Plasticity, exposure, and training. *Music Perception*, 17, 437-459.
- Cohen, A.J. (2001). Music as a source of emotion in film. In P. Juslin & J. Sloboda (Eds.), *Music and emotion* (pp. 249-272). Oxford: Oxford University Press.
- Cohen, A.J. (in press). How music influences the interpretation of film and video: Approaches from experimental psychology. In R. Kendall & R. Savage (Eds.), *Selected reports in ethnomusicology: Special issue in systematic musicology – Musical meaning, expression and communication*.
- Cook, N. (1987). The perception of large-scale tonal closure. *Music perception*, 5, 197-205.
- Cook, N. (1993). Perception: A perspective from music theory. In R. Aiello (Ed.), *Music perceptions* (pp. 64 - 95). New York: Oxford.
- Cook, (1998). *Analysing musical multimedia*. Oxford: Clarendon Press.
- Cowen, P.S. (1988). Manipulating montage: Effects on film comprehension, recall, person perception, and aesthetic responses. *Empirical Studies of the Arts*, 6, 97-115.
- Cowen, P.S. (1992). Visual memory, verbal schemas, and film comprehension. *Empirical Studies of the Arts*, 10, 33-55.
- Cowen, P.S., & Lebel, A. (1998). The influence of story, plot, and genre on memory for action in a film. *Empirical Studies of the Arts*, 16, 71-83.
- Croonen, W.L.M. (1994). Effects of length, tonal structure, and contour in the recognition of tone series. *Perception and Psychophysics*, 55, 623-632.
- Cuddy, L.L., Cohen, A.J., & Mewhort, D.J.K.M. (1981). Perception of structure in short melodic sequences. *Journal of Experimental Psychology: Human Perception & Performance*, 7, 869-883.
- Cuddy, L.L., & Lunney, C.A. (1995). Expectancies generated by intervals: Perceptual judgments of melodic continuity. *Perception and Psychophysics*, 57, 451-62.
- Deliège, I. (1987). Grouping conditions in listening to music: An approach to Lerdahl & Jackendoff's grouping preference rules. *Music Perception*, 4, 325-360.
- Deliège, I. (2001). Prototype effects in music listening: An empirical approach to the notion of imprint. *Music Perception*, 18, 371-407.
- Deutsch, D. (1999). *The psychology of music*. 2nd ed. New York: Academic.
- Eisenstein, S.M. (1942). *Film sense*. (J. Leyda, Trans.). New York: Harcourt.
- Eisenstein, S.M. (1949). *Film form*. (J. Leyda, Trans. & Ed.). New York: Harcourt. (Original work published 1939.)
- Fechner, G. T. (1860/1966). *Elements of psychophysics*, Vol. 1. (H.E. Adler, Trans.). New York: Holt, Rinehart, & Winston.
- Fichman, N. (Producer), & Girard, F. (Director). (1998). *The Red Violin* [Film]. (Available from Cineplex Odeon.)
- Frankland, B. W. (1998). *Empirical tests of Lerdahl & Jackendoff's (1983) low-level group preference rules for the parsing of melody*. Doctoral dissertation, Dalhousie University, Halifax, Nova Scotia.
- Frankland, B. W., & Cohen, A.J. (1996). Using the Krumhansl and Schmuckler key-finding algorithm to quantify the effects of tonality in the interpolated pitch-comparison task. *Music Perception*, 14, 57-83.
- Frankland, B.W., & Cohen, A.J. (in press). Parsing of melody: Quantification and testing the local grouping rules of Lerdahl & Jackendoff's (1983) "Generative theory of tonal music." *Music Perception*.
- Frijda, N.H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

- Gilman, K. (1999). *Le Violon Plaisant*. [Review of a film]. Retrieved from the Web /10/02. [http://www.people.fas...ilman/reviews/movies/red\\_violin.htm](http://www.people.fas...ilman/reviews/movies/red_violin.htm).
- Green, D.M. (1980). *Form in tonal music: An introduction to analysis* (2nd ed.). New York: Holt, Rinehart & Winston.
- Hale, M. (1980). *Human science and the social order: Hugo Münsterberg and the origins of applied psychology*. Philadelphia, PA: Temple University Press.
- Heider, F., & Simmel, M. (1944). An experimental study of apparent behavior. *American Journal of Psychology*, 57, 243-259.
- Helmholtz, H. von (1954). *On the sensations of tone. 4th ed.* (A.J. Ellis, Trans. & Ed.). New York: Dover. (Original work first published in 1887.)
- Hochberg, J. (1986). Representation of motion and space in video and cinematic displays. In K. Boff, L. Kaufman, & J.P. Thomas (Eds.), *Handbook of perception and human performance: Volume 1 Sensory processes and perception* (pp. 22-1-64). New York: Wiley.
- Hochberg, J., & Brooks, V. (1996a). Movies in the mind's eye. In D. Bordwell & N. Carroll (Eds.), *Post-theory: Reconstructing film studies* (pp. 368-387). Madison, WI: University of Wisconsin Press.
- Hochberg, J., & Brooks, V. (1996b). The perception of motion pictures. In M.P. Friedman & E. C. Carterette (Eds.), *Cognitive ecology* (pp. 205-292). New York: Academic Press.
- Johnson, B.D. (1998). Firing up the festival. [Review of the film *The Red Violin*.] *Maclean's*, 37, p. 58.
- Kalinak, K. (1992). *Settling the score*. Madison, WI: University of Wisconsin Press.
- Krumhansl, C.L. (1979). The psychological representation of musical pitch in a tonal context. *Cognitive Psychology*, 11, 346-374.
- Krumhansl, C.L. (1990). *Cognitive foundations of musical pitch*. New York: Oxford.
- Krumhansl, C.L. (1998). Topic in music: An empirical study of memorability, openness, and emotion in Mozart's string quintet in C major and Beethoven's string quartet in A minor. *Music Perception*, 16, 119-134.
- Krumhansl, C., & Shepard, R. (1979). The psychological representation of musical pitch in a tonal context. *Cognitive Psychology*, 11, 346-374.
- Krumhansl, C.L., & Toivianinen (2001). Tonal cognition. In R.J. Zatorre & I. Peretz (Eds.), *The biological foundations of music* (pp. 77-91). New York: New York Academy of Sciences.
- Landy, F.J. (1992). Hugo Münsterberg: Victim or visionary? *Journal of Applied Psychology*, 77, 787-802.
- Landry, L. (1927). La psychologie du cinéma [The psychology of the moving picture]. *Journal de Psychologie*, 24, 134-145.
- Leontiev, D.A., Petrov, V.M., & Sorkin, V.S. (1992). Empirical aesthetics in the former USSR: Selected topics. In G.C. Cupchik & J. László (Eds.), *Emerging visions of the aesthetic process* (pp. 194-209). Cambridge, UK: Cambridge University Press.
- Lerdahl, F., & Jackendoff, R. (1983). *A generative theory of tonal music*. Cambridge: MIT.
- Levin, D.T., & Simons, D.J. (2000). Perceiving stability in a changing world: Combining shots and integrating views in motion pictures and the real world. *Media Psychology*, 2, 357-380.
- Levinson, J. (1997). *Music in the moment*. Ithaca, NY: Cornell University Press.
- Lipscomb, S. (1999). *Cross-modal integration: Synchronization of auditory and visual components in simple and complex media*. Collected Papers of the 137th Meeting of Acoustical Society of America and 2nd Convention of the European Acoustics Association, Berlin. Available on CD Rom from ASA.
- Mach, E. (1886/1897). *Contributions to the analysis of the sensations*. (C. M. Williams, Trans.). Chicago, IL: Open Court Publishing.
- Machlis, J., & Forney, K. (2000). *The enjoyment of music. 8th ed.* New York: Norton.
- Magliano, J.P., Miller, J., & Zwaan, R.A. (2001). Indexing space and time in film understanding. *Journal of Applied Cognitive Psychology*, 15, 533-545.
- Marshall, S.K., & Cohen, A.J. (1988). Effects of musical soundtracks on attitudes toward animated geometric figures. *Music Perception*, 6, 95-112.
- Marvin, E.W., & Brinkman, A. (1999). The effect of modulation and formal manipulation on perception of tonic closure by expert listeners. *Music Perception*, 16, 389-408.
- Meyer, L. (1956). *Emotion and meaning in music*. Chicago, IL: University of Chicago Press.
- Mitry, J. (1997). *The aesthetics and psychology of cinema*. (C. King, Trans.). Bloomington, IN: Indiana University Press. (Original abridged work published in 1990; original work published in 1963.)
- Münsterberg, H. (1916/1970). *The photoplay: A psychological study*. New York: Arno. (Republished by Dover as *The film: A psychological study*.)
- Münsterberg, M. (1922). *Hugo Münsterberg: His life and work*. New York: Appleton.
- Murray, D. (1988). *A history of western psychology. 2nd edition*. Englewood Cliffs, NJ: Prentice Hall.
- Narmour, E. (1990). *The analysis and cognition of basic melodic structures: The implication-realization model*. Chicago, IL: University of Chicago Press.
- Newton D. (1973). Attribution and the unit of perception of ongoing behavior. *Journal of Personality and Social Psychology*, 28, 28-38.
- Nyssonen, P. (1998 October). Film theory at the turning point of modernity. *Film-Philosophy: Electronic Salon*. Retrieved from the Web 24/06/00. <http://www.mail->

- base.ac.uk/lists/film-philosophy/files/nyyssonen.html.
- Peretz, I. (1989). Determinants of clustering in music: An appraisal of task factors. *International Journal of Psychology*, 24, 157-178.
- Pollard-Gott, L. (1983). Emergence of thematic concepts in repeated listening to music. *Cognitive Psychology*, 15, 66-94.
- Schellenberg, E.G. (1996). Expectancy in melody: Tests of the implication-realization model. *Cognition*, 58, 75-125.
- Schlemmer, M. (2000). *Music as actor*. Presentation to the 13th Film-und Fernsesehwissenschaftliches Kolloquium (FFK) [Film and TV-science colloquium], Göttingen, Germany.
- Schmuckler, M. (1997). Expectancy effects in memory for melodies. *Canadian Journal of Experimental Psychology*, 51, 292-306.
- Schönplflug, W. (1994). The road not taken: A false start for cognitive psychology. *Psychological Review*, 101, 237-242.
- Shepard, R.N. (1964). Circularity of judgments of relative pitch. *Journal of the Acoustical Society of America*, 36, 2346-2353.
- Sklar, R. (1993). *Film: An international history of the medium*. Harry N. Abrams, Inc.
- Spillmann, J., & Spillman, L. (1993). The rise and fall of Hugo Münsterberg. *Journal of the History of the Behavioral Sciences*, 29, 322-338.
- Sragow, M. (1999). Making film is making music: Director François Girard on the art of making art. Retrieved from the Web /10/02 <http://www.salonmag.co...l/srag/1999/07/01/violin/print.html>.
- Stam, R. (2000). *Film theory*. Malden, MA: Blackwell.
- Sterritt, D. (1999). Music drives "Red Violin": Interview John Corigliano. *Christian Science Monitor*, 91, 147, 15. Retrieved from the Web /10/02 <http://ehostvgw6.epnet.com/fulltext.asp>.
- Sylva, J. (1998). The red violin. [Review of a film]. Retrieved from the Web /10/02. <http://www.clearillusions.com/reviews-r-redviolinthe-98.html>.
- Tan, W. (Ed.). (1996). *Emotion and the structure of narrative film: Film as an emotion machine*. Mahwah, NJ: Erlbaum.
- Tarkovsky, A. (1986). *Sculpting in time: Reflections on the cinema*. (K. Hunter-Blair Trans.). Austin, TX: University of Texas Press.
- Thompson, W.F., Cuddy, L.L., & Plaus, C. (1997). Expectancies generated by melodic intervals: Evaluation of principles of melodic implication in a melody production task. *Perception and Psychophysics*, 59, 1069-1076.
- Thompson, W. F., Russo, F. A., & Sinclair, D. (1994). Effects of underscoring on the perception of closure in filmed events. *Psychomusicology*, 13, 9-27.
- Trainor, L.J., & Trehub, S.E. (1992). A comparison of infants' and adults' sensitivity to western musical structure. *Journal of Experimental Psychology: Human Perception & Performance*, 18, 394-402.
- Welker, R.L. (1982). Abstraction of themes from melodic variations. *Journal of Experimental Psychology: Human Perception and Performance*, 8, 435-447.
- Wicclair, M.R. (1978). Film theory and Hugo Münsterberg's "The Film": A psychological study. *Journal of Aesthetic Education*, 12, 33-50.