Part IV

Applications: Music and Sound in Multimedia

Chapter 12

Children's media: The role of music and audio features

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In days gone by, bards sang tales as they traveled from village to village, carrying their messages in a melodic form that was often memorable to listeners (Calvert & Tart, 1993). In the 21st century, contemporary 'bards' typically travel to listeners electronically through digital media, providing instantaneous global access to their music. How does exposure to electronically generated music through multimedia, as well as to other perceptually salient audio techniques like sound effects, affect moods, attention, and learning from infancy through early adulthood? And how do older youth use the symbolic systems of audiovisual media to create their own multimedia?

This chapter explores the effects of infants', children's, and adolescents' exposure to music presented in multimedia. The role of music on the moods and feelings of youth, including the link to learning, is examined. Auditory formal production features (i.e., sound effects, non-speech vocalizations, music, and singing, that are used to present multimedia content) are considered in relation to children's attention and learning of content. These non-content auditory features serve to influence children's attention to content by eliciting orienting responses—as well as by providing modes that children can use to think about and represent the visual and verbal content by, for instance, presenting language with melodies to make the words more memorable. The ways that older youth are now creating their own digital stories, using the same production techniques that they often enjoy viewing, are also considered. Finally, promising research directions for the field are advanced.

Exposure to music and song

Listening to music and songs is an activity that frames human interactions from the beginnings of life. Using a nationally representative survey in which parents were randomly called by land-line phones, the Kaiser Family Foundation reported on the media use patterns of children who were in the first 6 years of life (Rideout & Hamel, 2006). On a typical day, 82 percent of children under age 6 years spend some time listening to music. Slightly more infants aged 6 months to 1 year old listen to music (88 percent) than 2- to 3-year-old (84 percent) or 4- to 6-year-old children (78 percent). For those who listen to music, the average amount of time invested per day is 58 minutes, with

6-month- to 1-year-olds listening to music for slightly more time (74 minutes per day) than 2- to 3-year-old (60 minutes per day) or 4- to 6-year-old children (53 minutes per day). The overall picture that emerges, then, is that very young children are consistently exposed to a considerable amount of music each and every day from the beginnings of life. In addition, all 6 month- to 6-year-old US children are exposed to an average of about 1.5 hours of screen media a day. For the youngest children, that exposure often involves infant videos that use heavy concentrations of background music, and to a lesser extent foreground music and singing (Goodrich, Pempek, & Calvert, 2009).

Listening to music and songs continues to occupy a considerable amount of time by 8- to 18-year-olds. According to the most recent nationally representative Kaiser Family Foundation survey of media use (Rideout, Foehr, & Roberts, 2010), 8- to 18-year-old youth spend an average of 2 hours, 31 minutes per day with music and other audio media, an increase in time spent with media when compared to their earlier studies. Overall, there has been an increase of 47 minutes per day in listening to music among 8- to 18-year-olds from the 2004 to the 2010 surveys, the heaviest increase in exposure to any category of media (Roberts, Foehr, & Rideout 2005; Roberts, Foehr, Rideout, & Brodie, 1999). Mobile devices designed for listening to music contribute to this pattern. During 2008 and 2009, for instance, 79 percent of a nationally representative sample of 12- to 17-year-old US teens reported owning an iPod or other digital musical device which are used almost exclusively to listen to music (Lenhart, Ling, Campbell, & Purcell, 2010).

In the most recent Kaiser Family Foundation survey (Rideout et al., 2010), the amount of time spent listening to music increases with age, with 8- to 10-year-olds listening to only about 1 hour of music and other audio media per day, but 18-year-olds investing an average of 3 hours per day. Girls listen to more music than boys (Rideout et al., 2010). However the gender gap in listening to music is beginning to disappear according to the most recent Kaiser survey due to the introduction and concentration of iPods, MP3 players, cell phones, and computers in the hands of preadolescent and adolescent youth. Minority youth are especially heavy users of music. Eight- to 18-year-old Hispanic youth listen to music an average of 2 hours, 52 minutes per day, African American youth listen to music an average of 2 hours 42 minutes per day, and Caucasian youth listen to music approximately 1 hour 48 minutes daily (Rideout et al., 2010).

Exposure to music is also probably much higher for this age group than reported by the Kaiser Family Foundation because 8- to 18-year-old youth invest heavily in viewing television content, playing video games, and interacting on the computer in which there is a heavy concentration of music that accompanies the video features. Specifically, the average US 8- to 18-year-old is now exposed to 7.5 hours of screen media per day, and much of that exposure to television, games, and movies includes music and singing (Rideout et al., 2010). For instance, African American youth spend approximately 3 hours each day watching televised music videos, a format that combines music with video content (Ward, Hansbrough, & Walker, 2009). Music videos transmit cultural information and provide visual imagery consistent with the message of the song (Sun & Lull, 1986), perhaps making them a source of cultural pride for minority youth.

Listening to music often occurs during multitasking, in which multiple activities are done simultaneously; multitasking often involves more than one media platform

at a time, such as listening to music as youth write a paper on their computer for a homework assignment (Rideout et al., 2010; Roberts et al., 2005). In fact, 73 percent of 7th to 12th graders reporting multitasking while listening to music (Rideout et al., 2010). Thus, how children perform at other tasks while listening to music, particularly their homework assignments, is of considerable importance for understanding what US children take away from their everyday experiences. This topic will be discussed in more detail later in the chapter.

In summary, music is a favored activity of infants, children, and adolescents throughout their development. Very young children make up a captive audience, listening to the music that their parents or other adults choose for them, whereas older youth select their own tunes. Listening to music has increased over time for older youth, in part due to increased access to mobile devices that allow youth to listen to music wherever they are. Minority youth and girls are particularly likely to listen to music, though boys are increasingly choosing to listen to music as well. Overall, music and singing provide a backdrop for many everyday activities as well as take center stage at times. How do these extensive experiences that children and youth spend with audio and audiovisual media influence developmental outcomes? Why do youth choose to spend so much of their time listening to songs and musical tracks? We turn now to the important role that music plays in mood regulation.

Music, mood, and emotions

Music often elicits emotions and arousal from listeners. Indeed, one of the more widely-cited studies that presumably linked listening to specific kinds of music to spatial learning may actually be caused by mood changes. In their initial study, Rauscher, Shaw, and Ky (1993) found that college students increased on a combined score measuring performance on three spatial tasks after listening to a Mozart tape for 10 minutes. The comparison groups were students who listened to a relaxation tape or who sat in silence. Although spatial skills were higher immediately after exposure for those who had listened to Mozart music than for the other two groups, the effects wore off after 10 to 15 minutes. These results suggested an acute short-term improvement for spatial skills after listening to Mozart music, a finding that came to be dubbed by the media as 'the Mozart Effect.'

The Mozart Effect, however, was not replicated in subsequent research with adults. For example, when Steele, Bass, and Crook (1999) attempted to replicate the findings of the original Rauscher et al. (1993) study, they found no increases in spatial skills after listening to Mozart music. They did find an increase in mood. They argued that the Mozart Effect might be caused by mood elevation prior to testing which then boosted spatial performance in the original Rauscher et al. (1993) study.

Evidence to support mood changes by listening to Mozart music was further supported by a study of college students (Husain, Thompson, & Schellenberg, 2002). The tempo (fast or slow) and the mode (major or minor) of a Mozart sonata were manipulated. After listening to one of these four tapes, participants took a spatial task, an arousal measure, and a mood scale. Those who listened to the Mozart tapes that had faster tempos were more aroused than those who listened to Mozart tapes with slower

tempos. Moods were best after listening to the major mode. Performance on spatial tasks was better after hearing the Mozart music that was fast paced and after hearing Mozart music in a major mode. Thus, Husain and colleagues (2002) proposed that the improved spatial skills attributed to the Mozart Effect appeared to be mediated by feelings and arousal levels induced by the music.

Given the equivocal results from numerous studies about the potential beneficial outcomes of listening to music on spatial skills, Rauscher and Shaw (1998) subsequently argued that the effect was limited to the spatial-temporal task of their measure. Although there are discrepancies in the findings and the interpretations about how adults who listen to Mozart subsequently perform on tasks assessing spatial-temporal performance, nonetheless considerable enthusiasm was generated for the potential of music to enhance spatial as well as other kinds of cognitive skills, including those of the very youngest children. Indeed, interest in the Mozart Effect became pronounced when it was described in relation to children's learning from media, even though youngsters had not been studied at that point in time (see Bangerter & Heath, 2004; Rauscher, 2009). Rauscher (2009) also argued that her research had been misinterpreted, and that discussions about the beneficial effects of music on infants and children's brain function and general intelligence were beyond the scope of her original research.

As beliefs about the beneficial influences of early exposure to music ensued, videos with titles such as *Baby Mozart* and the *Mozart Effect for Babies* entered the infant and toddler marketplace. Although improvements in spatial skills after listening to Mozart music has not been empirically documented for infants, 5- to 9-month-olds do demonstrate musical preferences. Specifically, infants prefer happy to sad music, suggesting that certain emotional responses to music are innate or are at least apparent within the first year (Nawrot, 2003). The mood regulation facets of music may well be overlooked as a reason for why parents show baby videos to their very young children. Music may have a calming effect that could be accentuated by other kinds of formal features that are slow as well as by content that is familiar and soothing. During infancy, music is played to put infants to sleep as well as to engage them during their daily activities. Indeed, 6-month-old infants sustain their attention better when they view tapes of their mothers singing to them than when they view tapes of their mothers speaking to them, perhaps because singing is more repetitive than speaking, thereby helping infants to modulate their arousal levels (Nakata & Trehub, 2004; see also Shenfield, Trehub, & Nakata, 2003). Or music may be played to induce happy moods. Although older children do not select the same exact emotions, such as happy, sad, fearful, angry, or neutral, that adults do to describe the music they are listening to, children do select similar facial expressions and provide similar verbal descriptions to music as adults do, suggesting that they too sense the emotions of music (Nawrot, 2003).

One important factor in the identification of moods associated with music is the use of musical modes (e.g., major and minor). For example, Kastner and Crowder (1990) played musical pieces in major and minor modes to preschool and grade school children. Children then selected pictures that conveyed the feelings in the music. Although there were age-related improvements in matching moods to pictures connoting feelings, even 3-year-old children performed above chance level in mapping happy or contented pictures to major modes, and sad or angry feelings to minor modes. Using

Zajonc's (1968) theory of mere exposure, the authors argued that mere exposure leads to familiarity and then to liking of musical pieces. Since major modes are heard more often than minor modes, even children, they argued, come to associate the familiar major modes with happiness and the less familiar minor modes with sadness or anger.

The uses of music and the needs filled by listening to music are many and varied. When played in social settings, music can be used for courtship rituals, for the creation and maintenance of friendships, as a topic of conversation, and as a way to encourage dancing (Roberts & Christenson, 2001). Females are more likely to use music for social reasons than males are (Carroll et al., 1993). By adolescence, mood regulation is the major reason reported for listening to music (Christenson & Roberts, 1998). Listening to music is typically a solitary rather than a social activity, and hence, mood regulation via music is typically experienced in private settings, such as one's bedroom (Christenson, 1994). Females are more likely to listen to music to improve their moods or to dwell on melancholy moods, whereas males are more likely to use music to increase their arousal levels and to get excited (Larson, Kubey, & Colletti, 1989). Females also report listening to music to relieve feelings of loneliness more than males do (Roberts & Christenson, 2001). The sad feelings that adolescents feel after a relationship ends is one reason that adolescents may listen to sad and melancholy music (Zillmann & Gan, 1997).

Music videos, in which songs and visual images are combined, fill the needs of listener-viewers as well as influence their arousal level. High school students, for example, reported that they used music videos in part because they were bored (Sun & Lull, 1986). Music videos clearly have the potential to excite. When sexual and violent visual images were inserted into rock-music, college students reported more excitement, enjoyment, and appreciation of that video (Zillmann & Mundorf, 1987). College students also reported more emotional involvement when they heard an animated vignette with music than when the same music was heard without visual images, though their judgments about the music (e.g., tempo, melody, harmony) varied depending on the animated vignette that they viewed (Geringer, Cassidy, & Byo, 1996; Geringer, Cassidy, & Byo, 1997). Chapter 10 in this volume by Boltz reviews the literature about music videos in more depth.

Formal features of media

Entertainment media are presented through visual and auditory production techniques, known as *formal features* (Huston & Wright, 1983). Just as language is a symbol system that must be learned, so too are the formal features that are used to present content via electronic media. Although many believe that visual features are the reason that people watch television and other visual media, *auditory* features play an extremely important role as they tell us when to look.

Berlyne (1960) argued that attention is initially influenced by perceptually salient features that embody movement, contrast, incongruity, surprise, and complexity followed by habituation to salience per se as attention shifts towards a search for meaningful content. Using Berlyne's theory of perceptual salience, Huston and Wright (1983) theorized that attention is initially influenced by perceptually salient television production features. Such features include action in which characters move through space,

sound effects that include the 'booms' of explosions and the high-pitched whirring sounds of grinding engines in car races, rapid pace where there are frequent changes in location and characters, loud foreground music, and vocalizations, i.e., non-speech utterances such as the character Scooby Doo saying 'Scooby Dooby Doo!' or the character Fred Flintstone saying 'Yabba Dabba Doo!' With developmental change and experience with the media, Huston and Wright (1983) predicted that attention comes under the strategic control of the viewer-listener who is increasingly in search of meaningful content, at which time non-salient features, such as child, female, and male dialogue and background music that occurs during speech, increasingly influence attention. Put another way, this change from exploration as a function of perceptual salience to a search for meaningful content reflects a change from attention being controlled by *exogenous* external events, in which attention is controlled more by external stimuli per se—to *endogenous* control of attention, in which attention is increasingly under the volitional control of children.

This section of the chapter will explore the role of auditory features in multimedia designed for infants and children. The discussion will be divided into two parts, focusing first on (1) sound effects and vocalizations; and then shifting to the topic of (2) music and singing.

Sound effects and vocalizations: Effects on children's attention and learning in multimedia experiences

When children view media, they do not sit and stare at the content. Rather, they play with toys and look at the television content periodically. In addition to music, auditory features such as sound effects and vocalizations play an important role in children's attention to, as well as their learning from, audiovisual media.

In an early study that involved the children's television cartoon, *Fat Albert and the Cosby Kids*, Calvert and colleagues (1982) advanced two ways that formal features may influence children's attention to content. One pathway to attention was due to the perceptual salience of the features per se. Thus, when a striking sound effect such as a slide whistle occurs, children should look at the screen due to a primitive attentional orienting response. The second pathway to attention, known as the *marker function*, occurs when children *learn to associate* certain auditory features with important story information. For example, in this production, Fat Albert would say the vocalization 'Hey, Hey, Hey,' followed by important dialogue that was essential for understanding the plot. That vocalization was a marker for children who were familiar with this production and who were in search of the important story content. In essence, the vocalization tells them when to look. These two pathways represent the developmental change described earlier in which infants and very young children shift from exogenous to endogenous control of attention.

Once visual attention is gained through either the salience or the marker functions of features, Calvert and colleagues (1982) expected that contiguous presentation between the salient auditory feature and the story content would provide one pathway to comprehension. That is, temporal proximity between the salient feature and story content would enhance the probability of children learning whatever followed the perceptually salient auditory feature.

Perceptually salient auditory features for attention and early learning from video during infancy

In a study of 6-, 9-, and 12-month-olds, Gola and her colleagues examined infant attention to both auditory and visual formal features for four different infant video programs, two of which were high in pace and two of which were low in pace (i.e., the rate of scene and character change). For auditory formal features, the researchers found that character vocalizations, foreground music, and background music were more likely to elicit attention when each of these features was present rather than absent for all age groups (Gola, Kirkorian, Anderson, & Calvert, 2011). Similarly, 12-, 15-, and 18-month-olds reliably oriented to vignettes from the *Baby Mozart* series when sound effects, such as a metronome or a ticking sound, were presented on the audio track, regardless of prior exposure (Barr et al., 2008). Taken together, the results suggest that perceptually salient audio features reliably elicit infant attentional orienting responses to the screen.

The shift to an understanding of the marker functions of perceptually salient auditory features appears to emerge in the first year of life, at least for very short video vignettes that are made just for experiments. Barr, Wyss, and Somander (2009) exposed 6-, 12-, and 18-month-olds to a 1-minute video in which sound effects were either matched or mismatched to the target actions, such as taking a mitten off a puppet. Four different sound effects were used. In the matched condition, the sound effects were a 'popping' noise when a mitten was taken off of a puppet, a 'swooshing' noise when the puppet moved, a ringing bell as the mitten was shaken, and a 'squelching' sound as the mitten was put back on the puppet. The same sound effects were used in the mismatched condition, but the sounds were out of synch with the puppet actions. Infants viewed the video six times. After a 24-hour delay, deferred imitation was assessed to measure memory of the task. Six-month-old infants imitated the task whether the sound effects matched the presentation or not, but 12- and 18-month-old infants imitated more target behaviors correctly when sound effects were matched rather than mismatched with target actions. These results also suggest a shift from exogenous control of attention by external stimuli to endogenous volitional control of attention at about age 1 year. Put another way, infants learn to discriminate and can use sound effects that are synchronized with targeted actions to improve their learning between the ages of 6 and 12 months.

Perceptually salient auditory features for attention and learning from television during early childhood

In a study of the cartoon, *Fat Albert and the Cosby Kids*, Calvert et al. (1982) examined the naturally occurring formal features of the program in relation to preschoolers' and kindergarteners' versus 3rd and 4th grade children's learning of important plot-relevant content. The formal features were first scored, and questions that assessed comprehension of the central plot-relevant and the incidental content were generated. Then children viewed the program and answered the multiple-choice questions that assessed their understanding of the program content. The central story plot was about children who liked doing non-traditional activities, in this case Penny who was a talented athlete who could kick a football out of sight, and Fat Albert who liked to cook.

By contrast, incidental content involved humorous events such as the rather robust Fat Albert character jumping behind a rather thin Native American statue that fully hid him, an event accentuated by a sound effect that went 'zip!'; this event did not advance the plot.

A consistent vocalization used in the program by Fat Albert, the main character, was 'Hey, Hey, Hey' followed by the words, 'I've got something to say.' Important plot-relevant content typically followed that vocalization. Children of both age groups were more attentive when sound effects and vocalizations were present rather than absent. As predicted, attention during the presence of character vocalizations improved both age groups' recognition of central television content. More specifically, children who paid attention when the character vocalizations occurred remembered more of the central plot-relevant content than did the children who were less attentive during these vocalizations. Put another way, by eliciting young children's visual attention at key program points, the character vocalizations increased children's comprehension of the contiguously presented content. Attention during vocalizations and sound effects also predicted comprehension of incidental content for the preschoolers and kindergarteners, but not for the 3rd and 4th graders, which suggests that the older children were better able to use features as markers of important content than were the younger children. Thus, there appears to be a shift from using the salience, attention-getting role of features that is based on primitive orienting responses to changes in the environment to the marker function of audio features in which children understand the meaning of features sometime between early and middle childhood for programs designed for a middle-childhood audience.

The role of auditory features for attention and comprehension using experimentally inserted sounds at key program points was the next research direction. Scene transitions, for example, are a critical time for children to attend to a program. If children attend during these transitions, they are more likely to see important story content that needs to be linked across program boundaries in order for them to understand the story narrative. To illustrate, for instance, in an episode of the children's program *Spanky and our Gang* called 'Mama's Little Pirates,' the scene shifts from Spanky being asleep in his bedroom to a new scene in which he is going to search for pirate treasure as part of a dream sequence. A giant eventually chases Spanky in this dream for stealing his gold, at which point the scene shifts again and Spanky wakes up in his bed. If children are not looking during those transitions, they may experience more difficulty with story comprehension.

In an experimental study using this scene from *Spanky and our Gang*, Calvert and Gersh (1987) inserted three sound effects of a slide whistle at the important scene transitions where Spanky goes from being awake to going to sleep to being awake again. In the sound effect condition, each of these three transitions was highlighted with a 1-second sound effect. The control group viewed the same story, but without the sound effects. Kindergartners' recognition of the most difficult plot-relevant content was improved when they heard sound effects during these three scene transitions when compared to the kindergarteners who did not hear these sound effects. By contrast, older 5th graders did not need sound effects to understand the story plot. These results suggest that sound effects can improve comprehension for young children if they are

used selectively to highlight important scene changes that need to be processed for mature story comprehension.

Rapidly paced programs, in which there are frequent changes of scenes and characters, place particularly heavy demands on children's ability to integrate key program information (Wright et al., 1984). Think of pace as being part of a play, with the curtain going up and down, sometimes to a new place (which would be a new scene) and sometimes to a familiar place (which would be a familiar scene). Characters also come and go from each stage setting, just as they do in television, film, and video scenes. When those changes occur rapidly, they place demands on the audience to integrate changes in time and place that are necessary to understand the story.

To assist children with these information processing demands, Calvert and Scott (1989) inserted five sound effects of a slide whistle into two live-format commercial children's television programs that were either high or low in program pace (i.e., the rate of scene and character change). The control versions of these programs had no sound effects. The rapidly paced program, titled *Search and Rescue*, involved trained animals who rescued a father and son who were in a car accident. In the slowly paced program, titled *Thunder, the Adventures of a Superhorse*, Thunder helps save a dog that drank poisoned water from a mine. Preschoolers and 4th-grade children viewed one of these four versions of these programs and then completed sequencing tasks where they put pictures in order that came from the central story scenes. Children of both age groups were more likely to attend to the key program transitions in the rapidly paced program when sound effects were present rather than absent. Selective attention at these key story transitions also predicted comprehension of the rapidly paced program. By contrast, attention during the slowly paced program did not vary by sound effect condition, presumably because it was already easy to follow the flow of action of the slowly paced television program.

Summary

Taken together, the results suggest the value of sound effects and character vocalizations as a way to draw attention to key program content, thereby leading to temporal integration of key program events and comprehension of central story content. That is, sound effects and character vocalizations can help young children link and integrate important program content across transitions, fill in knowledge gaps, and understand central program content when they are viewing television programs. The effectiveness of these salient features to guide attention occurs very early in development when used with simple experimentally made video presentations. Perceptually salient audio features such as sound effects and vocalizations initially draw attention and influence learning because they elicit primitive orienting responses that later shift to purposeful attention and learning, with these same kinds of audio features now serving as a marker of important content. This salience function is especially useful for children who are age 5 or younger who have difficulty determining which content is important, particularly when viewing a dynamic story presentation. Perceptually salient audio features are also easily integrated into existing programs, making them a very cost-effective way to improve children's comprehension of televised stories.

Music and singing: Effects on children's attention and learning in multimedia experiences

As discussed earlier, Calvert and colleagues (1982) identified two ways that formal features can influence children's attention to content: through perceptually salient features (such as a high-pitched whistle) that elicit a primitive attentional orienting response; and through the *marker function*, which occurs when children associate specific auditory features with important story information—for example, learning that a recurring harp *glissando* indicates that a character has transformed into a superhero.

In an analysis of television programs designed for a preschool and grade school audience, Huston and colleagues (1981) examined the use of perceptually salient and non-salient features. Based on their analyses, they created a third cluster of features, known as *reflective*, because it provides children with opportunities to rehearse content. Singing, for example, was classified as a reflective feature because it combines repetition with language that is presented melodically rather than spoken, thereby providing opportunities to *rehearse* the content (Huston et al., 1981). Rap music, though, is an exception to this definition as it uses rhythmic language in ways that can potentially be very catchy and attention getting to audiences.

In a more recent analysis of the formal production features used in infant videos, Goodrich and colleagues (2009) found that no singing occurred in almost one-third of the productions and 60 percent had no rhyming. This finding was surprising given that reflective features such as singing were expected to be prevalent in videos designed for very young children as they provide an opportunity for repetition and rehearsal of content. The authors also expected to find perceptually salient techniques like sound effects and character vocalizations to be used just before dialogue occurred as these sounds can create attentional orienting responses to language. Indeed, sound effects often occurred when both child and male dialogue were onscreen, and character vocalizations often occurred when females were speaking to another character. Because foreground music is perceptually salient, foreground music was expected to occur more than background music that contains speech. Surprisingly, contrary to prediction, non-salient background music that contained speech was twice as prevalent as perceptually salient foreground music that had no speech. In other words, music with characters speaking in the background were found to be more prevalent in the infant videos reviewed by Goodrich and colleagues than music with no speech.

The previous discussion on the role of sound effects and vocalizations focused mainly on the two kinds of formal features directing children's attention to content identified two ways that formal features can direct children's attention to content: (1) perceptually salient features eliciting a primitive attentional orienting response and (2) the 'marker function' described earlier. The following discussion shifts to a focus on music and singing, which will address both of these functions as well as highlight (3) 'reflective' features particularly where singing is used to support memorization and learning. As we shall see, the role of music and singing in children's engagement with multimedia is somewhat complex; the following discussion encompasses both attention and distraction effects of music, as well as the benefits and limitations of incorporating songs and singing in children's learning.

Attention and distraction effects of music for imitation tasks on video during infancy

Infants and preschoolers are more likely to look at television content when lively music is present rather than absent (Anderson & Levin, 1976), particularly when they are familiar with the music (Barr, Zack, Garcia, & Muentener, 2008). For example, Barr and colleagues (2008) showed 12-, 15-, and 18-month-old infants a portion of an episode of *Baby Mozart* from the *Baby Einstein* series or *Kids Favorite Songs 2* by Sesame Workshop and recorded their visual attention to the videos. Infants who had viewed *Baby Mozart* before looked more during musical segments than those who had no prior exposure to this series.

Audio features have been used to help call attention to the content, sometimes with disruptive outcomes. For instance, Barr and colleagues (Barr, Shuck, Salerno, Atkinson, & Linebarger, 2010) conducted an experimental study in which 6-, 12-, and 18-month-olds were exposed to a 1-minute video in which the auditory track included background music or no music. The background music was 'Clubhouse Capers.' The visual track depicted a puppet with a televised adult demonstrating key actions, such as pulling a mitten off a puppet's hand and then shaking it. Infants viewed the vignette six times. Deferred imitation was then assessed 24 hours after exposure. Infants who heard the musical track play in the background during the video presentation performed no better than the infants who had no exposure to the task at all. In other words, hearing the musical track reduced infant performance to baseline levels. When a live adult exposed infants to this same task three times with the same music in the background, infants were able to demonstrate the imitation task.

The results suggest that there was a cognitive overload when music was added to the video presentation, forcing infants to allocate scarce attentional resources to multiple tracks simultaneously without a clear signal about which content was most important. If, as Goodrich et al. (2009) found, background music is often presented with characters also speaking in the background, this may be particularly challenging for infants. The implication is that background music on videos can overload infants' and toddlers' developing cognitive systems by requiring them to simultaneously process language, music, and video images, thereby disrupting infants' skills to detect what they should be attending to. In a second related study (Barr et al., 2010), an additional vignette was created that added sound effects to accompany the music. When sound effects were added to mark the targeted actions on the musical video presentation, performance improved, but it still did not surpass a condition in which there was no music. (These challenges of cognitive load are not limited to infants and children's engagement with multimedia. See also chapters by Grimshaw, Tan, and Lipscomb; Shevy and Hung; and Roginska, in this volume, for similar implications for cognitive load in the context of video games, television advertisements, and auditory displays.)

Memorization and recitation of sequentially presented information during the preschool years

One important consideration in processing musical tracks may involve the novelty of the tune. If the music is novel, it may place more demands on memory than a familiar

tune. For example, Calvert and Billingsley (1998) taught kindergarten-aged children their phone numbers by either singing or speaking the numbers in a short song. A novel tune was selected for the singing condition. Although we predicted that information that is organized sequentially, in this case a series of numbers, would be better recalled when presented in a song, we found the opposite effect. That is, young children recalled their phone numbers from a spoken presentation better than from a sung presentation. The novelty of the tune was expected to impede learning, an interpretation that is consistent with the demands placed on memory when there are multiple tracks to be processed simultaneously. That is, children had to think about the novel music as well as their phone numbers. Perhaps initially familiarizing children as well as infants with a melody may lead to better learning from music.

In another study, Calvert and Billingsley (1998) also examined how well preschoolers could recite the lyrics, recognize the central plot-relevant content, and sequence visual items after one or multiple exposures to an animated French or English version of the song 'Frère Jacques.' After multiple exposures, English-speaking preschoolers could actually recite the French version of the song better than the English version. However, only age predicted better recognition of the central content or sequencing of the visual story content with older children outperforming the younger ones on both tasks. Taken together, these experiments indicated that singing improves verbatim memory of information, but that a deeper understanding of the verbal messages presented in songs is problematic for preschoolers. Our findings support the educational practice of repeatedly exposing very young children to songs that teach verbatim memories of sequentially presented material, such as the 'ABC' song, but it calls into question the use of songs to help children understand the actual content of vignettes.

Why, though, do preschool teachers so often use songs to teach young children if the children are not really learning much beyond a rote recitation of the lyrics? Surely the teachers would have noticed? Perhaps the motor rehearsal that accompanies songs in preschools, in which children enact key actions, can help toddlers understand the meaning of a song. To test this hypothesis, Calvert and Goodman (1999) had toddlers sing several songs with an adult who either played a guitar while singing or who sang the lyrics while displaying actions that conveyed the song meaning. For instance, toddlers either sang 'I'm a Little Teapot' and tipped their bodies over as they and the adult 'poured out' the tea, or they just sang the song as an adult played it on a guitar and sang it with them. The toddlers who used enactive, body movements as ways of rehearsing the song lyrics subsequently understood the meaning of the songs better than those who simply sang them without the aid of motor rehearsal. Interestingly, one of the groups of children made up their own tea party when motor aids were not part of their condition. The implication is that the motor behaviors provided an additional modality to think about and to encode the content, which, in turn, enhanced children's understanding of the song lyrics.

Superficial processing of educational messages of sung videos from middle childhood through early adulthood

As mentioned earlier, singing is a 'reflective' feature because it allows children to rehearse the same content when the chorus is sung repeatedly (Calvert & Tart, 1993).

Singing also combines the two symbol systems of language and music (Huston et al., 1981), thereby providing dual modes to represent content. Although educators have often thought that singing is a useful way to improve learning, singing typically provides a bridge to verbatim memory, rather than to comprehension of content, even at older ages. Much of the research on this question involves a series called *Schoolhouse Rock!*, an instructional video series designed to teach children history, science, mathematics, and English. In this series, short video vignettes of approximately 3 minutes presented animated bits with singing to accentuate the message. Does exposure to these video vignettes improve children's or adults' learning?

In one of the first studies of *Schoolhouse Rock!*, Calvert and Tart (1993) examined the Preamble to the Constitution, a part of the history rock vignettes that were originally televised and later presented as videos. Two versions of the video were created: one involved the original video, and the other involved a spoken rather than a sung version that was dubbed onto the original video track. College students then heard the Preamble several times in either spoken or sung conditions. After exposure was completed, immediate and then very long-term recall of the words to the Preamble was assessed. Verbatim memory of the exact temporal order of the Preamble was better for those who had been exposed repeatedly to the sung rather than to the spoken version of the vignette. The results linked repeated exposure to a sung vignette to both very good short-term and long-term memory of words, implicating singing as a way to improve verbatim memory of scholastic tasks. Even so, students at times mixed up the words, and hence the meanings, of the passages. For instance, one college student wrote 'to ensure the blessings of liberty to ourselves and our *prosperity*' instead of '… our *posterity*.' Thus, it was unclear if processing of songs was any deeper than a rote recitation of the content. This finding is consistent with Craik and Lockhart's (1972) levels of processing theory in which they argue that some information is processed at a relatively superficial level at the expense of a deeper integration of the content with existing information in memory. In our case, students may have been processing songs at a relatively superficial phonic level without thinking about the meaning of the lyrics that they were hearing.

In two subsequent experiments (Calvert, 2001), the role of two additional *Schoolhouse Rock!* videos on children's memory was examined. The first involved 'The Shot Heard Round the World,' a *Schoolhouse Rock!* history vignette about the start of the American Revolution, to shed light on whether children actually understand the information embedded in songs. In this study, the use of a visual or a nonvisual track was manipulated with an audio track that was sung or spoken. Second grade children and college students were exposed to the vignette one time. Contrary to prediction, children recognized information, as assessed by multiple-choice items, better when it was presented as a spoken track rather than as the original sung track.

'I'm Just a Bill,' another *Schoolhouse Rock!* video vignette, depicted the process of how a bill becomes a law in the United States. Using a narrative, the bill, who is depicted as an animated piece of paper with writing on it, tells his story to a young animated boy. In the second experiment, this vignette was shown in its original form to 3rd graders and college students and manipulated whether students viewed the vignette repeatedly (four exposures over a period of 2 weeks) or viewed it only once (Calvert, 2001). Verbatim

word-for-word recall, verbal sequencing of how a bill becomes a law, and assessment for recognition of important educational content (as indexed by a multiple-choice recognition test), took place immediately after the last exposure. Repeated exposure increased children's and adults' verbatim recall of the sung material and their verbal sequencing of the steps required for a bill to become a law. Thus, songs improved memory of material that follows a sequential pattern. However, repetition did not improve children's or adults' recognition of multiple choice items that assessed their memory of important story content. When asked what a bill was, one child said that a bill was 'something that you pay' and another said that a bill was 'a piece of paper with writing on it.'

Repetition again emerged as a key reason that 2nd graders learned science information from a *Schoolhouse Rock!* video episode about 'Interplanet Janet,' a vignette that conveyed information about the solar system. Kotler and Wright (1998) exposed groups of children to a spoken or a sung version of this video either two or four times and compared their performance to a control group. Those who viewed the video four times in either the spoken or sung conditions remembered more conceptual information about the solar system than those who saw the video only twice, who in turn, remembered more information than those who had no exposure to the video at all. Thus, spoken and sung exposures had similar effects on memory in this study.

Morton and Trehub (2007) found support for both content and form when interpreting the emotional connotations of songs. Children who were ages 5 and 10 years and adults listened to music that conveyed emotion through cues such as tempo and vocal tone. Some of the music had lyrics that were consistent with the emotions of the song whereas others had nonsense lyrics. Songs were then judged as being happy or sad based on the feelings expressed by the singer's voice. Emotions were judged correctly when they were conveyed by nonsense lyrics, suggesting that children and adults alike understand performance cues. These findings are consistent with a 'level of processing' framework in which lyrics are processed at a superficial phonic level rather than at a deeper level of understanding (Craik & Lockhart, 1972). However, when real lyrics were part of the audio track, children relied more on the lyrics for judging emotion, but adults continued to rely on cues such as tempo and vocal tone for judging emotion. Because children and adults had been asked to make judgments about emotional feelings based on the sound of the singer's voice, adults' decisions were in keeping with directions.

However, these findings do not mean that listeners do not attend to the meaning of any of the lyrics that they hear. Although adolescents say that they choose their favorite songs based on the sound, the lyrics are also an important reason that many of them report liking certain songs (Roberts & Christenson, 2001). For example, approximately 17 percent of 12- to 18-year-old males and almost 25 percent of females report that their favorite song has lyrics that express how they feel (Rosenbaum & Prinsky, 1987). Youth who listen to the musical lyrics the closest report that they tend to do so because music is important to them, or because the lyrics are controversial (Christenson & Roberts, 1998).

Distraction effects of multitasking on middle-aged adults memory and high school students' homework performance

Basic research about the role of listening to music on short-term memory sheds light on the role that music may play on multitasking, such as studying while listening to music

or completing homework assignments in front of the television. As mentioned earlier, almost three-quarters of 7th to 12th graders reported multitasking while listening to music (Rideout et al., 2010). In a series of experiments that used a variety of musical excerpts on memory, researchers Salame and Baddeley (1989) examined the role of vocal music, instrumental music, silence, and 'pink' noise on college students' through middle-aged people's immediate memory of nine visually presented digits. Overall, vocal music impaired short-term memory the most. Instrumental music also disrupted short-term memory, but not as much as vocal music did. Silence and 'pink' noise, the latter being non-speech sounds presented at the same amplitude, were least disruptive to short-term memory. The authors argued that working memory involves a detection system that could involve positive or negative filters. In the case of a negative filter, the acoustic system may allow certain sounds to pass through while screening out others, much like a coffee filter stops the coffee grinds from passing through the filter, but not the actual liquid. Thus, speech passes through the filtering system more readily than uninformative noises. Alternatively, in the case of a positive filter, the acoustic system could privilege certain information over others, such that it is sensitive to language. In either case, memory would involve a detection and storage system that is preferentially responsive to speech or speech-like sounds.

When background television programs are played while 8th graders are doing their homework, performance is disrupted on memorization tasks as well as on paper and pencil assignments, but audio presentations did not disrupt performance (Pool, Koolstra, & van der Voort, 2003a; Pool, Koolstra, & van der Voort, 2003b). The implication of this research is that watching television programs disrupts homework assignments, in part because youth watch the programs instead of concentrating on the homework task. However, music appears to have differential effects, with background music often yielding no disruptive effect, but with vocal music interfering with homework performance, perhaps because listeners may be distracted when the music and the homework assignment require verbal processing of language, thereby creating an interference effect.

Summary

Taken together, the findings suggest that singing provides an excellent and durable way to rehearse and remember content in a verbatim form and is also an important vehicle for conveying mood. However, if the goal is to improve comprehension of the message, speaking the same content instead of singing it is the most consistent approach for improving comprehension. These findings support Craik and Lockhart's (1972) levels of processing theory in which content can be processed at a superficial level without a deeper understanding of the meaning of that content. It appears that singing, unless accompanied by enactive rehearsal techniques where children act out the meaning of the content of songs, such as 'I'm a Little Teapot,' tends to be a superficial learning technique, whereas the use of language without singing is more likely to receive deeper processing.

Singing, then, can enhance learning, but it is best suited for tasks that involve verbatim memory or sequencing that is sensitive to the order of material. Although songs are very durable memories, a challenge for learning from songs is to get children and

even adults to go beyond the surface and dig deeper for meaning. Because songs provide such an efficient structure for remembering the associated linguistic content, it is possible for youth to process the content at any time, given that the specific words, of course, were coded accurately in the first place. There is also a substantial minority of youth who do pay close attention to musical lyrics. Because vocal music and television content can disrupt short-term memory of verbal content as well as homework performance during multitasking, listening to vocal music or watching television should be minimized when doing homework assignments, particularly for complex tasks. Consistent with this thesis, background music played during a video also disrupts relatively simple imitation tasks by overloading the limited cognitive resources that infants bring to a viewing situation.

Youth, digital communications, and digital creations

The 21st century increasingly offers youth opportunities to navigate the Internet and to make digital productions rather than just consume the productions of others. Most youth are now 'digital natives,' a term coined to reflect the ease with which they traverse and understand the digital landscape because they have used digital media throughout much of their development (Prensky, 2001). For instance, youth often send information to one another through the Internet. Among teens who use instant messaging, 31 percent reported sending music or video files (Lenhart, Madden, & Hitlin, 2005). Forty-three percent of online teens also make purchases online, such as music (Lenhart et al., 2005), though many youth also go to sites where they can download music for free, violating copyright laws in the process.

Certain kinds of music are integral to adolescent identity expression, reflecting the broader cultural influences in which they live. In a study of the social networking site Facebook conducted by Pempek, Yermolayeva, and Calvert (2009), more than 64 percent of college students included their favorite music in their profile information, which is the place where people share personal information about themselves. Of the sixty-four percent of students who included their favorite music in their profile information, 65 percent of those students indicated that they did so because it was important information that expressed 'who I am.' In fact, media preferences were more likely to be reported in user profile information and to be selected as integral to identity than were traditional identity markers such as religion or political views (Erikson, 1963).

Technological advances offer youth opportunities to be more than just consumers of multimedia but to also take part as producers of their own digital creations. The multimedia creations of 'digital natives' reflect a remarkable level of 'multimodal literacy.' In an innovative study, Wingstedt, Brändström, and Berg (2008) gave young adolescents (aged 12 to 13 years) some pieces of music and asked them to shape the music to fit three short three-dimensional animated films in real time, as they viewed the animations. The seven musical parameters the participants were able to control and adapt (using REMUPP software) were instrumentation, tempo, harmonic complexity, rhythmic complexity, register, articulation, and reverberation level. A high level of agreement was found among 23 young adolescents' creations in their use of these parameters to fit the visual scenes, reflecting a shared knowledge of musical narrative

codes and conventions most likely absorbed through exposure to films, music videos, computer games, and other narrative multimedia.

Rap music is a preferred genre among African American adolescents (Roberts et al., 2005) that reflects a larger hip-hop culture. Since African American youth often listen to rap music and view music videos (Ward et al., 2009), music may be a major focus of the media content that these adolescents not only view, but also create. Do the production features of music videos also find their way into digital productions made by minority youth?

To answer this question, Baker, Staiano, and Calvert (2011) examined the digital creations made by twenty-four African American adolescents who were attending a college preparatory summer program at Georgetown University, which is located in Washington, DC. This procedure allowed adolescents even more creative freedom than in the Wingstedt et al. (2008) study. Students were taught basic film editing techniques and then given a camera to take pictures about their summer experiences on campus. The students then edited and integrated those pictures into a visual narrative that included audio material. Because adolescents spend a considerable amount of time watching music videos (Ward et al., 2009), students were expected to use formal features such as songs and foreground music with no background dialogue in their digital productions. Students' digital productions included one to four songs, averaging 1.5 songs per production. Consistent with previous literature (Roberts et al., 2005), African American youth included rap music the most in their productions (37.5 percent), but there was considerable musical variety. Specifically, about 29 percent of these students used pop, 21 percent used rock, and 13 percent used rhythm and blues music in their productions. Perceptually salient foreground music, in which there was no accompanying speech, was used more than non-salient background music that included speech on top of the musical track. These findings suggest that African American students copy the popular music video formats that they listen to and watch, integrating that style into their own digital productions to make original content. The implication is that the forms that are viewed of others' lives can become an integral part of creative expression when applied to one's own life experiences.

Future research directions

Over 20 years ago, Kastner and Crowder (1990) argued that developmental and cross-cultural research were key areas to explore in order to unravel the genetic and environmental contributions between certain musical tones and feelings. Nevertheless, the extant literature on a variety of developmental and cultural issues about music remain somewhat of a mystery. One promising research area involves when and how children begin to interpret different kinds of music, and how that understanding changes with age. The use of multiple symbol systems can either enhance, or detract from, learning the content embedded in multimedia presentations that involve singing, foreground music, background music, language, visual images, sound effects, text, and non-speech vocalizations. When do overlapping symbol systems assist learning, and when do they create an overload in information processing activities? Why do children and adults so often stay on the surface when listening to the lyrics of a song, and what

prompts them to dig deeper for meaning? How does using media with different kinds of music affect academic performance, such as homework assignments, and does performance vary depending on the kind and the complexity of the task?

It may also be the case that older children could benefit from interventions used with younger children when the content is more complex. For instance, could sound effects assist comprehension during middle childhood if children are watching a program intended for an adult audience? Cross-cultural research of children at different points in development could also be a promising research direction to unravel universal relations of music and other auditory attributes on developmental outcomes.

Another promising research direction involves an examination of the kinds of digital products children and youth make, and how those products reflect important parts of their lives. Although media interfaces have rapidly evolved, the developmental needs of children are much more stable. For instance, children create identities that are reflected in their digital products (e.g., as reviewed earlier in the study by Baker et al., 2011). Do different age groups create other products that reflect who they are and what their needs are, using the rich symbol systems of media to convey that sense of self?

Better understanding is needed about why some children and youth listen to certain kinds of songs and music to alter depressed moods, and why others listen to music to sustain depressed moods. According to mood-management theory, individuals organize their environments to diminish bad moods, to change bad moods to good ones, and to sustain and accentuate good moods (Zillmann & Gan, 1997). Therefore, if music can be used to change a mood when a teen feels unhappy, is it functional to accentuate and sustain an unhappy mood? If so, why? What are the underlying motivations that lead different youth to use music in disparate ways?

Finally, what role does silence play in the 21st century? Youth are constantly wired to electronic media, often listening to music during their adolescent years (Rideout et al., 2010). Is quiet time when reflection takes place being lost in the process, and if so, what else is being lost—perhaps the imaginative activity that flourishes during times of reflection (Valkenburg & Calvert, 2012)?

Conclusions

Audiovisual media now permeate the landscape of symbolic communication, with rich musical and other attention-getting audio features accompanying and accentuating the visual images, and shaping their understanding of the unfolding story. While music and songs provide an additional structure and modality for thinking about and rehearsing television and video content, they can also overload infants', children's, and even adolescents' information processing systems if they do not tightly overlap with and map onto the visual and thematic messages that they are meant to convey. Music also sets the stage for interpreting character feelings, and for thinking about the underlying motives that inspire and that motivate characters to act. These important functions make it important for educators, film-makers, and musicians alike to employ production practices that enhance learning by linking the emotions and the arousal that are elicited by auditory features to the messages that listener-viewers are meant to take away. Twenty-first century youth may not wait for

adults to implement these practices, instead creating their own digital creations to represent their realities.

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