

Learner Preferences in Multimedia Design

Ray Pastore
Assistant Professor of Instructional Technology
University of North Carolina Wilmington
601 S. College Rd
Wilmington NC, 28403
rayme.pastore@gmail.com
<http://raypastore.com>



ABSTRACT: *From the multimedia research, a number of design principles have been developed in order to improve learning by reducing burden on working memory load (i.e., the multimedia principles). However, very little of this research has attempted to examine learners' preferences of multimedia design. As a result, the purpose of this study was to examine learners' preferences for multimedia in order to see if design principles align with learner preferences. The results of the study indicate that learners' preferences partially align with the multimedia principles. Learners preferred multiple to single representations, which is directly in-line with the multimedia principle. However, learners overwhelmingly preferred text + narration + images which directly violates the redundancy principle. They indicated that they prefer options. They enjoy seeing the images and then want to choose if they want to listen, read, or do both. Given these results, it is clear that the multimedia principles are not always aligned with learner preferences.*

Keywords: Multimedia Principle, Cognitive Load, Modality Principle, Coherence Principle, Split Attention Principle

Received: 19 June 2016, Revised 26 July 2016, Accepted 2 August 2016

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1. Introduction

Multimedia is everywhere. From the TV to the phone, tablet, magazine, newspaper, billboard, etc. multimedia is part of our lives. In schools, businesses, and government agencies, it's used for a multitude of tasks (e.g., delivering messages, advertising, training/learning, etc.). In the literature, multimedia is defined as a combination of verbal and nonverbal representations that support learning and/ or communication (Mayer, 2005). Given its popularity, it's no wonder that there is a plethora of

research on multimedia learning dating back several decades. This research has yielded a number of recommendations for multimedia design called the multimedia principles, which aid the development of multimedia content by improving learning and decreasing the load on working memory (Mayer & Moreno, 2003). The multimedia principle research indicates that learning from multiple representations (verbal and non-verbal) is better for learning than just one (Mayer, 2014; Eitel, Scheiter, & Schuler 2013; Sung & Mayer, 2012; Pastore, 2010). Additionally, the multimedia principle is used by designers and developers to create quality content for learning and communication purposes. However, while much of the principle's research focuses on the design of multimedia, little focuses on learners' preferences for these design principles (Pastore, 2014). Instead, it focuses on ways to increase learning by best utilizing short- and long-term memory; very rarely are learners asked if they enjoy it. As a result, the following paper will address the learners' preferences of multimedia design.

2. The Multimedia Principle

According to the multimedia principle, a combination of verbal and visual representations, that explain for one another, are better for learning than just one (Mayer, 2005; 2014). This idea has roots in a number of theories including information processing, cognitive load theory, and dual coding (Mayer & Moreno, 2003; Sweller, 1999; Baddeley, 1998; Paivio, 1986). From these theories emerged the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2005), which states that there are dual channels for information processing, that each channel has a limited capacity, and that active processing between short- and long-term memory is utilized to recall prior knowledge (Mayer, 2014). According to Mayer (2014), the dual channel assumption implies that there are two channels in working memory: a verbal channel and a visual channel for processing information. Each can process information in unison or independently from one another. The limited capacity assumption infers that each channel can store a limited number of concepts or ideas at one time. Finally, the active processing assumption presumes that cognitive processing between short- and long-term memory is required to create meaning from the presented content.

Numerous studies support the multimedia principle and the CTML (Hegarty and Just, 1993; ChanLin, 2001; Pastore, 2010; Issa, Mayer, Schuller, Wang, Shapiro, and DaRosa, 2013). For example, Eitel, Scheiter, and Schuler (2013) found differences in favor of multiple representations for achievement of high level (transfer/problem solving) knowledge when presenting university students with text vs. text and images. Eilam and Poyas (2008) found similar results in a study which found differences in both recall and comprehension when learners were presented with multiple vs. single representations. They presented university students with content on cell phones and found the multiple representation group performed significantly better than the single representation group. In another study, Sung and Mayer (2012) discovered that multiple representation conditions performed significantly better on recall tests than participants in a single representation condition. As a result of this vast amount of support, numerous other principles have spawned from the multimedia principle to aid the design of instructional content in a multimedia environment. For purposes of this paper, only the modality, split-attention, redundancy, and coherence principles will be discussed.

2.1 The Multimedia Principles: Split-attention, Modality, Redundancy, and Coherence

Mayer and colleagues have developed a number of design principles from the multimedia principle and the CTML (Mayer 2005; 2014). These principles are designed to improve learning by helping to minimize working memory load (Mayer 2001; 2009). Each is an extension of the multimedia principle and helps the designer during curriculum development. These principles are not rules that must be followed but rather best practices that should be considered for each project. While there are a number of multimedia principles, the discussion here will focus on four: split-attention, modality, redundancy, and coherence principles. For further reading on all of the multimedia principles please see Mayer (2014).

The split-attention principle posits that when learners view multiple representations, such as text and images, they need to go back and forth between the two in order to comprehend the concepts presented (Ayres and Sweller, 2014). This phenomenon is called representation holding and has been shown to increase the load on working memory causing a decrease in learning (Pastore, 2012). As a result, in order to offset this increase in working memory, the modality principle hypothesizes that verbal representations should be in the form of narration (spoken words) so that learners do not need to go back and forth between representations but can hold their attention on the visual while listening to the verbal instruction (Low and Sweller, 2014). Neto, Huang, and Melli (2015) demonstrated this in an experiment where 91 participants were presented with either audio or text in computer-based instruction. They found that learners in the audio multimedia group outperformed the text-based group on a transfer measure and reported lower levels of cognitive load. Izmirli and Kurt (2016) uncovered comparable results in a study which found that participants presented with narration and animation outperformed participants presented with written text and animation. Similar conclusions can be found throughout the literature (Kalyuga, Chandler, and Sweller, 1999;

Moreno and Mayer, 2002; Ginns, 2005). Therefore, presenting images and narration rather than images and text can lower working memory load leading to an increase in learning. However, what happens if both text and narration are presented together?

When presenting duplicate information via multiple representations (i.e., text and spoken narration) learning is inhibited. This is referred to as the redundancy principle which postulates that presenting both text and narration to the learner at the same time overloads their verbal processing channel and causes a decrease in learning (Kalyuga, Chandler, and Sweller, 2004). Sweller (2005) discusses two distinct types of redundancy that can occur and result in a decrease in learning: 1) each representation contains duplicate information, and 2) one representation contains keywords or summarized text and the other is detailed. A study by Pastore (2012) presented 154 university students with redundant text and narration with images or narration with images. Participants in the narration with images condition performed significantly better on problem-solving measures than participants in the redundant groups. Yue, Bjork, and Bjork (2013) found similar results in two experiments which found that participants scored significantly lower on achievement tests when presented with redundant representations. Therefore, presenting duplicate representations can suppress learning.

Additionally, the design of the representation can also have an impact on the learning process. When representations contain unnecessary details (i.e., details that will not help the learners with the learning objectives) the load on working memory is increased leading to decreased learning (Mayer, 2005; 2014). This is referred to as the coherence principle which suggests that representations should be designed to the learning objectives. For example, if designing instruction on tree leaves there would be no need to add birds to the branches, a tire swing hanging from the tree, or even color unless it were tied to a learning objective. This was demonstrated by Sung and Mayer (2012) in an experiment where participants were presented relevant graphics, non-relevant graphics, or no graphics. While participants indicated that they preferred graphics to no graphics, the relevant graphics group outperformed the others on the posttest. After analyzing 28 experiments, Mayer and Fiorella (2014) conclude that “overall, there is strong and consistent evidence for the coherence principle: people learn more deeply from a multimedia message when extraneous material is excluded rather than included” (p. 292). Therefore, representations, such as images, should only include details which serve the purpose of learning.

2.2 Learners Preferences of Multimedia

While there is a plethora of literature on the multimedia principle, very little has focused on learner preferences of multimedia (Pastore, 2014). Rather, much of the focus is on learning design and improvement. As designers, learner motivations, preferences, and attitudes are an important part of the instructional analysis (i.e., learner analysis) and are taken into consideration during the design process (Dick, Carey, and Carey, 2001). While there is very little research on learners’ preferences of multimedia, the research that does exist is not always in-line with the multimedia principle. For example, Pastore (2014) presented a survey to 114 university students to determine their preferences for multimedia in both learning and entertainment environments. While participants preferred multiple to single representations, which agrees with Sung and Mayer’s (2012) conclusion that learners prefer graphics to no graphics, their favorite presentation method included images and text with duplicate narration. This is not in-line with the redundancy or modality principles. Similar findings were uncovered by Yue, Bjork, and Bjork (2013) whose two experiments found that learners consistently preferred redundant text and narration even though they performed worse on recall and transfer tests when presented with this format. In addition, Yu, Zhang, Zhou, and Li, (2005) argue that learners should be able to select a media format that they find preferable as long that preference is also in-line with good design. A study by Plass, Chun, Mayer, and Leutner (1998) found that regardless of media preference (text, picture, video clip or all), learners that preferred multiple representations scored higher on recall tests than those who preferred the single representations. This suggests that learning is improved when learners are presented with multiple rather than single representations (i.e., the multimedia principle). However, they tend to prefer redundant text and narration over just text alone, which is not in-line with the redundancy principle. Why does the end user have this preference? Could finding out the answer to that question help designers create instruction that aligns with learner preferences and still meets best design practices? User preferences need to be taken into consideration when designing instruction, especially if a contract depends on user or client satisfaction. As a result, the study presented in this paper further examines this phenomenon.

2.3 Purpose

The purpose of this study is to examine learners’ perceptions of multimedia representations and cognitive load in order to help understand which representations they prefer and believe are the best for learning. When used in conjunction with best multimedia practices, the results of this study will help instructional designers and developers to make decisions about the types of representations to include in instruction. Since much of the research on multimedia has focused on learning rather

than preference, this study will help fill a gap in the multimedia literature and add to the literature base on learning preferences of multimedia.

3. Methods

3.1 Participants

The participants of this study consisted of 148 undergraduate university students at a medium-sized university in the United States. 80% were female and 20% were male. 96% were full-time students while 4% were part time. 93% were 18-21 years old, 6% were 22-30, and 1% were 31 or greater. They were all education majors. 92% indicated they own a smartphone, 49% own a tablet, 97% own a laptop, and 65% own a gaming system such as a Wii, Xbox, or Playstation.

3.2 Instrument and Procedure

The survey was made up of 37 questions. The first seven questions consisted of demographics information, disability information (hearing and seeing), as well as a question about technology experience. The remaining 30 questions examined the following media types: image only, sound only, text only, images with text, images with sound, images with redundant text and sound, black and white images with detail, color images with detail, black and white images with no detail, and color images with no detail. These 30 questions were comprised of: 10 questions which asked participants their preferences toward the media type (prefer or does not prefer), 10 questions which asked participants to rate how much mental effort (cognitive load) they believed it would take to learn from the media type, and 10 qualitative questions on participants' perceptions of the media type.

Each of the preference questions consisted of a Likert-scale question on a 5-point scale asking participants how much they would prefer the media type for learning from computer-based instruction. They were presented with a sample of the media type so that they could experience the media type before answering the questions. These Likert-scale questions and materials were adapted from the learner preference survey used in Pastore (2014). The questions were reviewed by an external instructional design faculty member to help ensure they were grammatically correct, not bias toward a representation type, and would answer the research question. Reliability for the Likert-scale questions was .71 (Cronbach's alpha). The cognitive load questions consisted of Likert-scale questions on a 7-point scale asking participants how much mental effort the representation would require for learning. This question has been used to assess learners' perceptions of cognitive load in a number of studies (Pastore, 2010; Mayer and Chandler 2001; Pollock et al. 2002). Finally, an open-ended response for each media type asked participants the rationale for their responses. These qualitative responses were coded for themes using the Open Coding Method as described by Corbin and Strauss (1990). In this method data is "broken down analytically" in order to "interpret phenomena reflected in the data" by finding categories, integrating/grouping to a point of saturation (Corbin and Strauss, 1990, p10). Participants were given the link to the survey via Survey Monkey and were able to participate during class lab time.

	Preference		Cognitive Load	
Representation	Mean	Standard Deviation	Mean	Standard Deviation
Image Only	3.12	1.03	3.79	1.51
Text Only	2.97	.94	3.52	1.49
Sound Only	2.69	1.15	4.03	1.72
Image + Text	4.13	.8	2.39	1.31
Image + Sound	3.45	.87	3.09	1.32
Image + Text + Sound	4.28	.97	2.20	1.49

*Preference was on a 5 point Likert Scale. 1= Does not prefer 5= Prefers

*Cognitive Load was on a 7 point Likert Scale. 1=Very easy 7=Very difficult

Table 1. Preference in Multimedia

4. Results

4.1 Results of the quantitative survey data

Results of the quantitative survey data were calculated via SPSS.

4.1.1 Multimedia Principle

As shown in Table 1, participants overwhelmingly preferred image + text and image + text + sound representations to all of the others. They also reported the lowest levels of cognitive load for these representations. These results are in-line with Pastore (2014) which found that participants overwhelmingly prefer multiple to single representations. The descriptive statistics are displayed graphically in Figure 1.

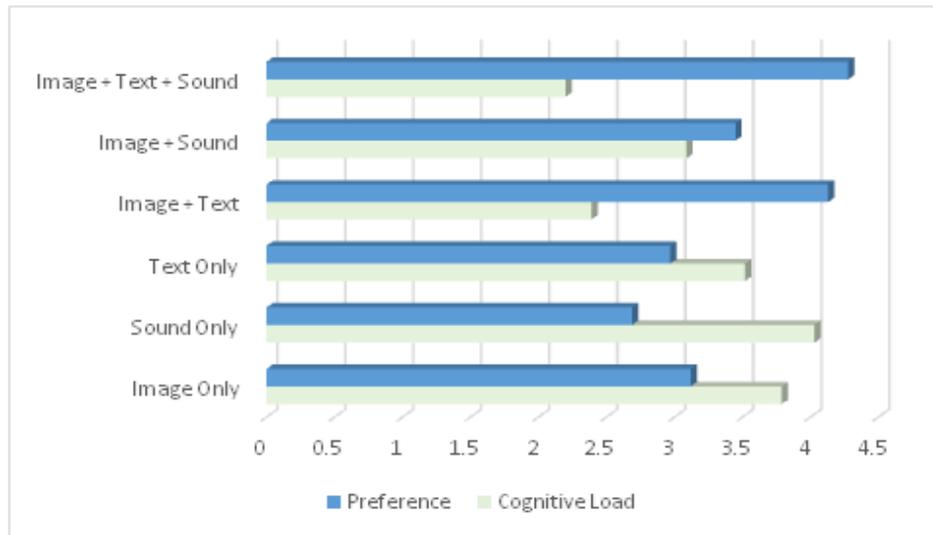


Figure 1

*Preference was on a 5 point Likert Scale. 1=Does not prefer 5=Prefers

*Cognitive Load was on a 7 point Likert Scale. 1=Very easy 7=Very difficult

4.1.2 Coherence

	Preference		Cognitive Load	
Representation	Mean	Standard Deviation	Mean	Standard Deviation
Black and White No Details	1.81	.97	5.49	1.62
Black and White Details	2.7	.94	3.93	1.52
Color No Details	2.45	.96	4.53	1.57
Color Details	3.66	.95	3.05	1.46

Table 2. Image details

*Preference was on a 5 point Likert Scale. 1=Does not prefer 5=Prefers

*Cognitive Load was on a 7 point Likert Scale. 1=Very easy 7=Very difficult

As shown in Table 2, participants overwhelmingly preferred color representations with extraneous details. Similarly, they reported the lowest levels of cognitive load from this type of representation. While participants preferred the extra details this is not in-line with the coherence principle which states that extra details hinder learning (Sung and Mayer, 2012). The

descriptive statistics are displayed graphically in Figure 2.

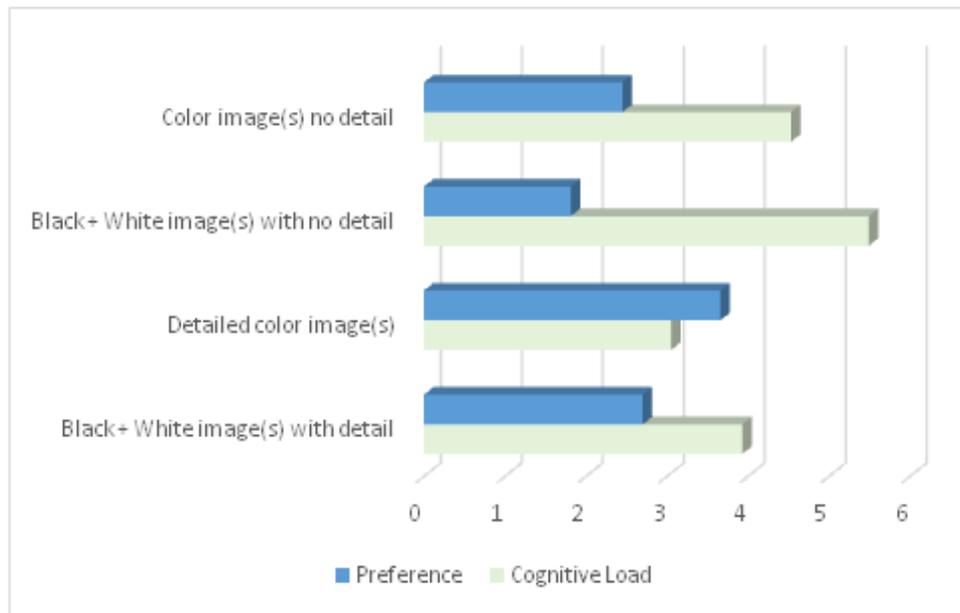


Figure 2. Image details

4.2 Results of the qualitative survey data

Qualitative data was coded and interpreted according to the Open Coding Method as described in the methods section of this paper.

4.2.1 Multimedia Principle

Analysis of the qualitative data was in-line with the survey findings. Participants indicated that they preferred multiple to single representations because they felt they led to better learning. Example quotes include:

“This method is one of my more favorable methods because I enjoy seeing text and images at the same time when learning this way my brain connects the two and I can recall the information easier”

“Not only does the text describe what the reader should be seeing in the picture, but the image allows the reader to understand what they are reading. They work hand in hand for better comprehension.”

Thus participants not only enjoyed this presentation method better but indicated that they felt they would be able to learn better with multiple representations. This aligns with the multimedia principle, which suggests that learning from multiple representations is better than just one (Mayer, 2014).

4.2.2 Modality Principle

The modality principle suggests that verbal representations should be in the form of narration (spoken words) with visuals so that learners do not need to split their attention between the representations (Low and Sweller, 2014). When presented with narration and images participants indicated that the images helped understand the sound but that they still preferred text; for example:

“I have a hard time listening to information and being able to retain it but with a picture as well it is easier to understand the sound and put it along with the picture.”

“It is a little easier to hear the sounds and see the images, but for me it is still difficult without text because I am a very visual learner.”

Many also stressed that without text, they would have a difficult time following along. For example, this participant indicates that they enjoyed the images with the sound but admitted that not having text makes it more difficult for them to understand:

“I think having images is going to be helpful when mixed with other forms of communication. The words and narration would be able to help explain what the image is and what the person speaking wants others to know about the presentation is about. However, without text, it may become difficult to follow along with what is being said.”

As a result, participants did not overwhelmingly support the modality principle. They preferred text to narration.

4.2.3 Redundancy Principle

Both the qualitative and quantitative data in this study was in-line with prior research on learners' preference for redundant (image + narration + text) representations over any other presentation method (Pastore, 2014; Yue, Bjork, and Bjork, 2013). However, this does not align with the redundancy principle, which hypothesizes that learning is inhibited when learners are presented with redundant representations, such as audio and text (Kalyuga, Chandler, and Sweller, 2004). For example, responses included:

“This offers a variety of learning styles to the student and I would prefer to learn like this. This is basically a triple threat. Sound, text, and images provide to every type of learners needs. It will also help keep the focus of your audience longer by adding new and exciting things, as well as images of what you are exactly talking about, so that your audience has a better understanding of your information.”

“I learn much better from using all three medias because it gives me various ways to take the information in. Including all three methods would strongly increase a student's understanding of the material, since everyone learns differently.”

While the majority of participants did prefer this method there were several that recognized some limitations to redundancy. For example, these participants indicated that it was:

“Pretty easy to understand but I personally would get distracted and overwhelmed as I would pay attention to one aspect or two aspects and ignore the others.”

“There is everything here, which I find complicated and cluttered. There is too much going on for all the different senses here, in my opinion.”

Overall, the majority of participants did prefer redundancy. Participants consistently preferred redundant text and audio representations.

4.2.4 Coherence Principle

The coherence principle suggests that unnecessary details may distract learners during instruction thus decreasing learning (Mayer and Fiorella, 2014). When presented with images that had both few and extraneous details, learners indicated that they prefer color images that are very detailed. They mention that this is what they are used to seeing and as a result what they prefer. For example:

“Color images are more modern, and children are used to seeing color images. This will most likely hold their attention more than the black and white images.”

“Seeing detailed images with color would be very easy for me. You can explain things a lot easier.”

Others suggest that they lack motivation when there are no details or color:

“Having no detail in a photo especially a black and white photo would make it very challenging to learn from because, in my opinion, it would be boring. Also, my brain would not retain the information because I would be bored and unwilling to learn.”

“Black and white is just kind of boring. Color would be better.”

“Color helps show every detail. It is also the main type of way that we see images, therefore, viewers would be used to it and be able to see every detail.”

Therefore, results of the qualitative analysis do not follow the coherence principle. Learners did not prefer black and white images to color; rather, they felt they would be boring/distracted by them. They also did not prefer the color images with very little detail. Instead, learners preferred the color images with details as that’s the media they are most familiar with.

5. Discussion and Conclusion

In the last several decades there has been a plethora of research on multimedia (Mayer, 2005; 2014). From this research, a number of design recommendations have been made to help designers decrease working memory load and increase learning. However, much of this research did not focus on learners preferences towards these design recommendations. As a result, the purpose of this study was to examine learners’ perceptions of the multimedia principles.

Overall it appears that learners’ preferences somewhat align with the multimedia principles. Learners preferred multiple to single representations, which is directly in-line with the multimedia principle (Mayer, 2005). However, given the popularity of podcasts for news, entertainment, and learning it was surprising that participants did not prefer the sound and image representations as much as the text and image representations. Learners indicated they prefer to be able to see the text for the ability to reread. Additionally, learners overwhelmingly preferred text + narration + images which directly violates the redundancy principle. One reason gleaned from the qualitative data was that learners prefer options. They enjoy seeing the images and then want to choose if they want to listen, read, or do both. This is in-line with Yu, Zhang, Zhou, and Li (2005) who recommend that instruction should be designed so that learners can choose their method of delivery. As a result, it is recommended that future research examines what learners choose when given the option to listen and read and how that impacts learning.

The participants indicated that they preferred detailed images with color. While the coherence principle indicates that learners can be overwhelmed by extraneous details, the participants highlighted that this is what they are used to and could get bored if the images are line drawings (not detailed), black and white, or just show enough detail for the learning objective.

Given these results, it is clear that the multimedia principles are not always aligned with learner preferences. So how do designers focus on today’s learners while still developing effective instruction? Today’s learners are used to many options and different types of multimedia that learners of 15 years ago did not have available. As a result, it would be worthwhile to examine how much these motivations affect performance and if previous findings have changed over time as learners develop strategies for dealing with various types of media representations.

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