THE INFLUENCE OF THEMATIC DISPLAYS ON THE

COMPREHENSION OF TEXT

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by

William Battinich

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ABSTRACT

THE INFLUENCE OF THEMATIC DISPLAYS ON THE COMPREHENSION OF TEXT

by

William Battinich

Master of Arts in Psychology
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The current investigation was designed to examine whether decorative graphics can function as thematic displays and whether these displays can influence learners’ comprehension of textual material. Learners were presented with a text describing the positive and negative aspects of romantic relationship with or without an accompanying thematic display. Some researchers have suggested that decorative graphics do not improve the recall of text nor increase the quality of learning outcomes. However, our results suggest that decorative graphics can act as thematic displays and also influence comprehension processes involved with the both the graphic and text. Our results demonstrate that thematic displays can activate a learner’s schema of a topic, thereby creating noticeable differences in the type of prior knowledge they bring to mind while processing textual material. Furthermore, the type of prior knowledge
that the learners incorporated into their essays about romantic relationships was distinctly different depending on which thematic display was viewed.
CHAPTER I

INTRODUCTION

The use of graphics to enhance learning has been demonstrated across a variety of tasks (Huk & Steinke, 2007; Mayer, Hegarty, Mayer, & Campbell, 2005; Zacks & Tversky, 2003). However, the types of graphics textbooks use may influence learners’ cognitive processes differently. The desired goal of combining graphics with text is to help facilitate the construction of a coherent mental representation of the learning material (Schnotz & Bannert, 2003). However, educators must be aware that graphics can differ in structure, informational content and computational efficiency (Schnotz & Bannert, 2003). Therefore, it is important to consider both the structure of a graphic and the type of information the graphic conveys in relation to a task. The investigation reported here was specifically designed to address this issue.

If a graphic is inappropriate to a task because it does not convey relevant information, it will be of little or no benefit to the learner; and instead, may have a detrimental effect on learning (Kirby, 1993). Similarly, two graphics that are informationally equivalent yet different in structure may influence how learners use the graphic and the type of information drawn from it. For example, if a decorational graphic is able to display an actual setting described in text, the graphic may help to organize and improve memory for the material (Levie & Lentz, 1982). However, when graphics are used principally for adornment they do not increase understanding of a task or deepen
learner’s comprehension of accompanying learning material (Elia, Gagatsis, & Demetriou, 2007; Levin, Anglin, & Carney, 1987). Thus, one type of graphic may be appropriate for one type of task and yet quite inappropriate for another. This condition led Carney and Levin (2002) to propose five different types of graphics to help researchers differentiate between graphic types based on function—specifically, graphics that serve the functions of representation, organization, interpretation, transformation, and decoration.

Representational graphics mirror all or part of the text content they accompany (e.g., a picture or photograph of the human skeleton when discussing the structure of human bones). Organizational graphics provide a structure for organizing the text (e.g., using a road map in conjunction with written or verbal directions). Interpretational graphics make complex or abstract texts more comprehensible (e.g., general psychology students are often presented with a picture of a computer when learning about the information processing function of the human brain). Transformational graphics act as mnemonic devices (e.g., showing a picture of a bell along with a text about Alexander Graham Bell to enhance memory for the name and associated facts). Lastly, decorative graphics are used principally for adornment and are not critical to the comprehension of the text (e.g., a picture of a syringe in a text discussing vaccinations). The point is that when a graphic is used in combination with a text, it is essential to determine the nature of the learning task, the type of graphic being used, and the learning outcomes intended from instruction.

Thus, the present investigation was designed to examine whether decorative graphics have a function beyond that of adornment and aesthetic pleasure per se—in the
study reported here, whether they function to convey information between the graphic and text at a level of semantic commonality—commonality as represented by common theme.
CHAPTER II

LITERATURE REVIEW

Multimedia

Within a learning environment, there may be times when it can be beneficial to use graphics to influence the way a student comprehends and cognitively represents textual information. The benefits to comprehension by combining graphics with text have been demonstrated by a number of different models. Dual-coding theory (Paivio, 1986), conjoint retention hypothesis (Kulhavy, Stock, Peterson, Pridemore, & Klein, 1992), and the visual argument hypothesis (Robinson & Kiewra, 1995) have all shown how the inclusion of graphics with text enhances comprehension.

Multimedia refers to the presentation of information to different modalities, such as verbal and visual, using multiple formats such as text and pictures (Mayer, 1997; Schnotz & Lowe, 2003). When using multimedia to present information it is beneficial to distinguished the type of technical device used to deliver the information, (book or computer) the mode or format of presentation (narration vs. text and static vs. animated graphics), and the sensory modality used to perceive the information (verbal or visual) (Mayer, 1997; Schnotz & Lowe, 2003). Although research has given attention to the impact of different technical mediums on learning outcomes (Mayer, 1989; Mayer & Gallini, 1990) results indicate that multimedia benefits can occur regardless of the technical medium used to convey the information. Schnotz and Lowe (2003) suggest that
focusing on media effects is misdirected and that research should focus instead on
different external communication formats and the different sensory modalities used to
process such information. However, Schnotz and Lowe (2003) also point out that there
are misconceptions concerning the use of different communication formats and sensory
modalities as well, and thus they are often misused. The primary misconception is that
presenting learners with several different information formats creates more possibilities
for the information to interact and integrate with one another. However, research
indicates that the exploitation of different multimedia formats can be detrimental to
learning. An experiment by Schar and Kaiser (2006) explored the effects on students
learning outcomes using a combination of text, graphics, and narration. The findings
revealed that the students’ recall of verbal facts, properties of the graphic, and their
ability to make inferences was best when presented with only a dual combination of text
and a graphic, or a narration with a graphic rather than the combination of text, narration,
and graphic. The question as to how learners cognitively integrate a combination of
graphics and text together can be best illustrated by two fairly recent models: Schnotz and
Bannert’s (2003) model of text and graphic integration and Mayer and Moreno’s (2002,

Comprehension as a Function of Graphics
and Text

The model proposed by Schnotz and Bannert (2003) discusses an integrative
approach to text and image processing. This model places greater importance on the
internal cognitive representations constructed by a learner from different symbol systems,
the principles involved, and the ways the two complement each other. The model
incorporates two systems of representations, a descriptive system and a depictive system (Schnotz, 2002)—both of which construct several mental representations. The descriptive system uses symbols and the depictive system uses icons.

The descriptive system begins with external text which is used to create an internal mental representation of the text’s surface structure (Schnotz, 2002; Schnotz & Bannert, 2003). The surface structure representation contains information extracted from the words, sentences and syntactic structure of the text (Schnotz, 2002; Schnotz & Bannert, 2003). This information is then used to construct a propositional representation containing information on the semantic content of the text. The creation of descriptive mental representations involves analyzing the symbol structures with both bottom-up and top-down processing (Schnotz, 2002; Schnotz & Bannert, 2003). The extraction of relevant information from text is accomplished through top-down processing and the conceptual organization of the representations is accomplished through an interaction of both top-down and bottom-up processing (Schnotz, 2002).

The depictive system begins with an external iconic picture that is used to construct an internal depictive representation of an image (Schnotz, 2002; Schnotz & Bannert, 2003). This perceptual representation of the image results from distinguishing the structural entities of the image and mapping them onto the representation (Schnotz, 2002). However, when constructing a mental model, the perceptual depictive representation must be comprehended through semantic processing (Schnotz, 2002). Thus, the mental model is constructed by mapping visual-spatial information with semantic information that is structurally relevant. Mental models can be constructed
through either bottom-up processing or by evaluating existing models through top-down processing (Schnotz, 2002).

Once the mental model from the depictive system has been constructed, new information can be extracted and integrated into the propositional representation through the process of model inspection (Schnotz & Bannert, 2003). Conversely, information from the propositional representation can be integrated to elaborate the mental model. In addition to the interaction between the propositional representation and the mental model, there may also be an interaction between the text surface representation with the mental model, as well as the image’s perceptual representation with the propositional representation of the text (Schnotz & Bannert, 2003). Schnotz’s model provides an explanation as to how the integration of text and images may enhance comprehension through the construction of mental models and propositional representations that combine the information of both. Furthermore, the interactions that take place between the representations of both the internal depictive and descriptive systems suggest how each may influence the organization of such representations.

Mayer and Moreno’s (2002, 2003) cognitive theory of multimedia learning is similar in internal structure to the model for graphic and text integration. Like Schnotz and Bannert’s (2003) model of graphic and text integration Mayer and Moreno’s cognitive theory of multimedia learning includes two different processing systems one for words and one for pictures. Within the verbal system, the learner is presented with the textual information which enters the learner’s sensory memory. With the information in sensory memory, the learner attends to and selects those features that are relevant to promote understanding. Those selected features are brought into what the author terms
“shallow working memory” (Mayer, 2003). Once the learner has selected those features that are relevant to meaning, the learner then organizes and constructs a coherent mental model representation of the text. The organizing process involves the learner establishing connections between the selected features with which they create their mental representations. The author describes these mental models as *deep working memory representations* (Mayer, 2003). Furthermore, the author proposes that the process of selecting and organizing is guided in part by the learners’ prior-knowledge (Mayer, 2003).

Likewise, for the pictorial system the learner is first presented with the physical representation of the graphic which enters the learner’s sensory memory. The learner then selects those features of the graphic that are relevant and brings the selected features into shallow working memory. From the selected features of the graphic, the learner organizes and constructs a coherent mental model of the graphical representation. The final process is that of integration. Once the learner has constructed their mental representation for the verbal and graphic information, they then integrate the two mental models with each other along with their own prior-knowledge of the topic. The integration process involves the creation of referential connections between the learner’s verbal representation and their mental graphic representation as well as the learners own prior-knowledge (Mayer & Moreno, 2002). The result is a new mental model that incorporates information learned from the verbal and visual representation along with previous learned knowledge of the material. The authors describe these mental models as *long-term memory representations* (Mayer & Moreno, 2002).
Schnotz and Bannert’s model of text and graphic integration (2003) and Mayer and Moreno’s cognitive theory of multimedia learning (2002, 2003) show many similarities with one another. Both models rely on several assumptions taken from different theories. From Pavio’s dual-coding theory (1986) and Baddeley’s working memory (1998) the models assume separate processing channels for both verbal and pictorial representations. From Sweller, van Merrienboer and Paas’s cognitive load theory (1998) the models assume that the two respective systems have a limited capacity to the amount of processing that can take place at any one time. Also, both models take a constructivist approach because the focus is on the creation of coherent mental models where learners must actively select the relevant information, organize the selected information into a meaningful mental representation, and integrate the model with prior-knowledge (Schnotz, 2002; Mayer, 1996). Thus, according to both models for meaningful learning to occur the learner must actively engage in these cognitive processes.

Although Schnotz and Bannert’s (2003) model of text and graphic integration and Mayer and Moreno’s (2002, 2003) cognitive theory of multimedia learning have a similar architecture they also differ from one another in some fundamental ways. First, Schnotz and Bannert (2003) state that the descriptive and depictive branches of their model are specialized for processing information presented in specific formats, regardless of which modality the learner uses to perceive the information. Conversely, Mayer and Moreno’s model of multimedia learning (2002, 2003) suggests that the difference between the verbal processing system and pictorial processing system is based on a combination of both how the information is perceived (verbally or visually) and how the
information is presented externally (Mayer & Moreno, 2002, 2003). In other words, Schnotz’s and Bannert’s model (2003) emphasize that information is processed in the descriptive branch regardless if the information is presented as a visual text or auditory narration while Mayer’s and Moreno’s model (2002, 2003) contend that the type of processing depends on both the modality used to perceive the representation (verbal vs. visual) and the presentation format (text vs. narration).

Another fundamental difference between the two models reflects the construction of multiple mental models. Mayer and Moreno’s (2002, 2003) cognitive theory of multimedia learning states that the processing of the verbal and pictorial channels result in two separate mental models: one constructed from the verbal information and one constructed from the pictorial information. Only after the two respective mental models are created are they integrated with one another along with the learners’ prior knowledge. Furthermore, the processing that takes place within the respective branches, are independent of one another until both mental models are constructed and then integrated. In contrast, the processing of Schnotz and Bannert’s (2003) model results in the construction of only one mental model that is built from combining features of the learners internal graphical representation with their internal propositional representation. Furthermore, distinctions can be made between how the models conceptualize the two processing systems. According to Mayer and Moreno (1998) when learners are presented with a visual text and a graphic split attention may occur because the need to process two visual information sources overload the pictorial systems processing capacity. Conversely, Schnotz and Bannert (2003) argue that the descriptive and depictive processing systems are based on different sign systems; the
descriptive system involves symbols for relations while the icons of the depictive system do not. Thus, the structure of the depictive system is not equipped to process verbal information regardless of whether it is presented as narration or visual text. Furthermore, a learner’s representations of the two different processing systems are going to be very different. However, research has produced some support for the cognitive theory of multimedia learning and the split attention effect. Mayer and Moreno (1999) investigated the differences in learning outcomes in students who were presented with either an animation and narration or an animation with text. Their findings revealed a consistent benefit in favor of the narration and animation group for the learners’ ability to solve transfer problems. Schar and Kaiser (2006) found that the combination of text and voice showed a greater benefit for the learners’ visual knowledge and a partial benefit in their ability to make inferences. A last difference between the processing systems of the two models is that in the model for text and graphic integration (Schnotz, 2002; Schnotz & Bannert, 2003) the descriptive and depictive processing systems are only independent at the lowest levels. The descriptive and depictive branches begin interacting with each other after the process of selecting the relevant features from the text and graphic occur. Conversely, according to the cognitive theory of multimedia learning (Mayer & Moreno, 2002, 2003) there are no interactions between the two processing branches until after the learner constructs the two respective mental models.

Finally, Schnotz’s and Bannert’s model suggest that the active processes of selecting, organizing, and integrating information happens in a step-by-step fashion. In other words, the model of text and graphic integration proposes that those processes involved in the creation of coherent mental models are fairly systematic. Mayer and
Moreno’s (2002, 2003) model on the other hand suggest that these processes operate in a more iterative manner. An experiment by Dutke and Rinck (2006) explored the differences in the integration of information and the construction of mental models between the two competing models. Their results revealed that the external descriptive and depictive representations do require a step-by-step construction process which is consistent with the model of text and graphic integration (Schnotz 2002; Schnotz & Bannert, 2003) but not the cognitive theory of multimedia learning (Mayer & Moreno, 2002, 2003). Furthermore, in the aforementioned experiment (Dutke & Rinck, 2006) modality was kept constant by presenting both the text and graphics visually. The findings lent further support to the model of graphic and text integration (Schnotz, 2002; Schnotz & Bannert, 2003) because it was revealed that the processing of text, when presented visually, required coordination between the depictive and descriptive branches at the lower processing levels which Schnotz and Bannert’s (2003) model accounts for and Mayer and Moreno’s (2002, 2003) model does not. As we can see, the two models discussed show some very fundamental differences but their similarities in internal structure make them both valuable tools for evaluating multimedia learning outcomes. Moreover based on the structure of the models proposed by Schnotz and Bannert (2003) and Mayer and Moreno (2002, 2003) we can derive certain recommendations for the design of multimedia learning environments.

Principles of Multimedia Design

Based on the internal structure of the two models certain design principles can be suggested and tested. The conveyance of information to learners’ has long been biased
towards verbal over visual forms. However, delivering information through a single medium such as text may not always be consistent with the way students learn (Mayer, 2003). Furthermore, current theories propose that meaningful learning occurs when students construct and coordinate visual and verbal representations containing corresponding information (Schnotz, 1993; Schnotz, 2002; Schnotz & Bannert, 2003; Mayer & Moreno, 2002, 2003). Meaningful learning can be defined as the active process of learners selecting relevant information from the text and graphics, organizing the information into representations, and integrating it with the learners existing knowledge (Mayer & Moreno, 2003; Schnotz & Bannert, 2003). This constructivist view of learning is inconsistent with earlier information delivery approaches that suggested adding information into memory is a matter of presenting it to the learner through words or text (Mayer, Heiser, & Lonn, 2001; Mayer, 2003).

The first principle we can derive from the two models is that the combination of text and graphics will provide for multimedia effects. Multimedia effects are the advantages seen in memory and especially deep comprehension when learners are presented with multiple representations (Mayer, 2003). According to the two respective models the presence of two processing channels enables learners to create two mental representations, one visual and one verbal, providing further retrieval cues to the learner as well as enabling cross-referential connections between the two representations (Schnotz, 2002; Mayer & Moreno, 2002). An article by Verdi and Kulhavy (2002) suggest that the advantage to memory is due to learners being able to hold both mental representations in working memory at one time. An experiment by Kulhavy, Stock, Verdi, Rittshof, and Savenye (1993) investigated how learners process corresponding
text and maps into memory. Learners were presented with either just the text or a combination of text and an intact map. The results indicated that those learners provided with the text and map were better able to recall features from the map and facts from the text. This suggests two things. First, having a graphic with which a learner can create a visual representation from enables them to retrieve information from both sources and secondly, the consumption on working memory capacity for intact maps or other intact graphics is small enough to still allow processing of the text information (Kulhavy et al., 1993). Mayer (1989) conducted an experiment investigating differences in performance outcomes between learners presented with text describing a cars breaking system, or text with graphics presenting the same information. The results from the experiment revealed that those learners presented with the combination of text and graphic performed significantly better on tests of recall and transfer ability then learners presented with only the text. These findings indicate that the creation of both verbal and visual representations allows the learner to construct referential connections between the two representations. Furthermore, when teaching students computer programming, McKay (1999b) investigated whether there were differences in learning outcomes between text, and text combined with graphics. Her results indicate that regardless of cognitive style, learners presented with the combination of text and graphics outperformed learners presented with text alone when asked to solve programming questions. Another experiment by Schar and Kaiser (2006) explored various combinations of media. Their findings revealed that presenting learners with a single media involving either image or verbal processing was actually detrimental to the acquisition of verbal knowledge when compared with to the presentation of dual media sources.
Taken together these findings all lend support to the idea that presenting learners with a combination of text and graphics results in multimedia effects which is consistent with the two models described above. Furthermore, the benefits can be seen across a number of different knowledge domains. The aforementioned experiments also lead us to the next principle for multimedia design. Derived from the models of text and graphic integration (Schnotz, 2002; Schnotz & Bannert, 2003) and the cognitive theory of multimedia learning (Mayer & Moreno, 2002, 2003), if the learners ability to hold both verbal and visual representations in working memory at the same time facilitates the creation of cross-referential connections, then we can assume that presenting graphics simultaneously with text will benefit learners to a greater extant than presenting graphics and text separate in time and space. The principles of spatial and temporal contiguity (Mayer, 2003; Mayer & Moreno, 2003; Betrancourt & Bisseret, 1998) suggest that deeper comprehension will occur when the text and graphics are presented together, spatially and temporally, rather than separately. In several experiments (Mayer & Anderson, 1991, 1992; Mayer, Moreno, & Boire, 1999) learners were presented with a text and graphic explanation of different scientific apparatuses simultaneously or the learners were presented with the text and graphic sequentially. The results from the experiments all indicate that learners receiving the text and graphics together display a greater depth of comprehension than learners receiving the text and graphics separately. Likewise, in another series of experiments by Mayer, Steinhoff, Bowers, and Mars (1995) learners were presented with text and graphical displays explaining how lightening works. The integrated group received the text and graphics together, while the separate group received the text first and then received the graphic. The results of the experiments
revealed that the integrated group significantly outperformed the separated group in terms of their ability to transfer what they learned to a new situation. However, all the experiments described above used explanatory information. An experiment conducted by Michas and Berry (2000) investigated the contiguity effect using procedural information. Learners were either presented the text and graphic together or sequentially on different screens. The results indicated that there were no significant differences in performance outcomes between the two groups. The authors do claim however, that the learners were allowed to study the information until they were confident in their ability to complete the task. This suggests that effects of contiguity maybe stronger when the learners are not familiar with the material and that through repeated exposure the learners may have been able to integrate the information. Rittschof, Stock, Kulhavy, Verdi, and Doran (1994) investigated whether there was an effect on the order of presentation when presenting learners with a map and text. The results of their experiment revealed that when learners are presented with the map before the text they are more successful at recalling text facts. These results indicate when two technical mediums cannot be presented contiguously at the temporal level presenting the graphic first allows the learner to create a coherent mental image of the graphic which serves as a retrieval cue for related textual information. Overall these findings lend considerable support to the idea that graphics presented simultaneously with text facilitates the creation of relevant cross referential connections as well as the construction of the learners’ mental models. Thus, these findings support the notion that presenting graphics with text at the same time allows the learner to hold both representations in working memory together which not only promotes the selection of relevant information but efficiency for model construction. This
is also consistent with both the model for text and graphic integration and the cognitive theory of multimedia learning.

A final principle that we can derive from both Schnotz and Bannert’s model (2003) and Mayer and Moreno’s model (2002, 2003) is one of coherence. The coherence effect suggests that deep comprehension from multimedia learning is best when irrelevant information is excluded from the text and graphics (Mayer, 2003). When interesting yet irrelevant information is added to a multimedia presentation learners pay attention to the irrelevant information which interferes with the organization process because they prime schemas that are not appropriate (Mayer, 2003). The coherence principle is also consistent and partly derived from Sweller et al.’s (1999) notion that the reduction of extraneous cognitive load improves the efficiency for germane cognitive load. In several experiments (Harp & Mayer, 1997, 1998) learners were presented with a text and graphic explanation about how lightning works. One group received an embellished version which contained irrelevant information in both the text and graphic, while the other group received a text and graphic conveying a concise explanation. When tested with transfer questions the results revealed that the concise group produced significantly more creative solutions to the transfer problems then the embellished group. The evidence is consistent with idea that when using multimedia extraneous material will hurt a learners understanding. These findings are all consistent with the model for the integration of text and graphics (Schnotz & Bannert, 2003) and the cognitive theory for multimedia learning (Mayer & Moreno, 2002, 2003) in that extraneous material will interfere with the learners selecting information that is relevant for the construction of mental models. Thus, the facilitation of comprehension through cross-referential connections between the two
information sources will be most effective when these design principles are adhered to. In light of our study, the findings from the aforementioned articles are important because they inform us how multimedia presentations can best support learning outcomes.

The two models (Schnotz, 2002; Schnotz & Bannert, 2003; Mayer & Moreno, 2002, 2003) mentioned above provide us with a good explanation concerning how text and graphics interact with one another, as well as certain design principles that should be adhered to when presenting multimedia. However, even when these principles are followed differences in learners’ ability to use the text and graphic to create mental models may still influence students learning outcomes. Schnotz, Picard, and Hron (1993) investigated differences between successful and unsuccessful learners mapping of graphical features onto their mental models. Specifically, Schnotz et al. (1993) were interested in whether successful learners focus on relevant model-building information more than unsuccessful learners, and whether successful learners retrieve model-building information when needed more often than unsuccessful learners. What the findings revealed was that successful learners focused on a larger portion of the graphic and mapped significantly more graphical features onto their mental models than unsuccessful learners. Furthermore, while it was shown that successful learners retrieved less information from the text overall, the information successful learners did retrieve was significantly more related to the creation of mental models than information retrieved by unsuccessful learners (Schnotz et al.). Specifically, successful learners retrieved model building information at points in which a new feature needed to be integrated into the mental model. Unsuccessful learners, on the other hand, showed a delay in retrieving the model-building information and they did not integrate the model building information
when the mental model needed elaboration (Schnotz et al.). The findings from this study are important because when learning from text and graphics the construction of mental models relies on both the relevance of the two information sources as well as the ways in which the learners are employing the use of the information provided. Thus, even when the text and graphic was informationally equivalent comprehension will rely on how well the learner can access and use that information to build a mental model. However, what is not known is whether different types of graphics will differentially influence students learning outcomes as well.

A study conducted by Schnotz and Bannert (2003) examined how different types of graphics combined with text effect learners visualizations of the information, and the influence of these different visualizations on the creation of mental models. Learners were presented with a text only or a text and one of two types of graphics (carpet diagram vs. circle diagram) depicting time-differences around the world. Learners then answered a series of time-difference and circumnavigation questions. The findings revealed that the structure of the learner’s mental models is dependent upon the structure of the graphic, learners’ presented with the carpet diagram were better at answering time difference questions, while those presented with the circle diagram were better at answering circumnavigation questions (Schnotz & Bannert, 2003). Furthermore, these findings support the structure mapping hypothesis which suggests that the features of a depictive graphic are mapped onto a mental model. Thus, graphics that are structurally different yet provide the same information will facilitate mental models that are structurally different as well (Schnotz & Bannert, 2003). Furthermore, the structure of the mental model maybe suited for some tasks better then others. These findings inform us that the
structure of the graphic will have an effect on the way the learners visualize the representation, which in turn will influence the structure of the mental model. Also, the structure of the mental model may differentially influence different types of learning tasks.

However, the graphics used in the majority of multimedia research and the aforementioned articles, all convey types of concrete knowledge to the learners. Thus, these types of graphics are supplemental in nature. They augment what the learner is reading from the text and directly facilitate the comprehension of the information. What we do not know is if the benefits to comprehension with supplemental graphics will also be present when using graphics depicting metaphorical themes.

Thematic Displays

A thematic display is an aggregated set of features, comprising as a whole, a generalized unifying or dominant concept or idea. Thematic displays are different from other graphical displays such as geographic maps, graphs, and diagrams, in that they do not provide any additional or redundant information to the learner; but instead convey an underlying theme or concept. Furthermore, thematically designed graphics are effective for displaying themes as long as learners are able to interpret them metaphorically rather than literally (Horn, 1998).

Kostelnick and Roberts (1998) suggest that the representations thematic clarity is a result of the organization of the graphics features along with the physical and visual clarity of the graphics lines and colors. Graphics that appear too abstract or whose contexts are too specific will not be effective in conveying themes (Willerton, 2005).
Schriver (1997) identified five modes in which graphics can be integrated with written language to both enrich and restrict meaning: redundant, complementary, supplementary, juxtapositional, and stage-setting. The stage-setting mode is best for displaying themes because stage-setting graphics provide the framework for the text content, allowing learners to predict what the underlying concept or idea may be (Schriver, 1997). Furthermore, Goldsmith (1984) suggests that three levels of unity should be followed for the use of thematic illustrations in educational contexts. The syntactic level involves learners making sense of the graphics parts, enabling them to interpret the whole form. The semantic level stresses that the theme should be easy recognizable in order for the learner to correctly infer the meaning and lastly, the pragmatic level deals with the learner’s familiarity of the thematic subject which facilitates learners ability to establish context. Foss (1994) suggests that when evaluating graphically depicted themes, learners’ interpretations rely on a three part rhetorical schema. The learner must first identify the function or action of the graphic. Secondly, based on the style and substance of the graphic the learner must decide how well the graphic supports the function. Finally, the learner makes a decision regarding the legitimacy of the graphics function. These guidelines are important because it informs us about the elements need to effectively convey a graphical theme.

**Metaphor Interpretation**

Thematic graphics utilize figurative expression, such as metaphors, to convey themes. Metaphors can override categorical boundaries and combine objects that typically belong in different domains (Kogan, Connor, Gross, & Fava, 1980). Metaphors
should also promote discovery by conveying information in an intuitive way that is consistent with the individuals’ perceptual and cognitive abilities. There are three components to a metaphor: 1) The *topic* is the concept being explained, 2) The *vehicle* is the concept that gives meaning to the topic, and 3) the *ground* is the basis which the topic-vehicle relationship is constructed (Tourangeau & Sternberg, 1982). In other words, the ground establishes an implicit link between the topic and vehicle allowing for a meaningful semantic relation. Furthermore, graphically depicted metaphors are able to describe positive or negative states in spatial terms though affective experiences may not be involved (Murphy, 1996).

Different approaches have been used to explain how metaphors function. Genters’ structural mapping hypothesis (1983; Genter & Clement, 1988) proposes that metaphors function by mapping knowledge from the *topic* concept onto the *vehicle* concept through a set of implicitly derived relations between objects of the *topic* and objects of the *vehicle*. Thus, if the relations within the topic concept align with those relations within the vehicles concept, then similarity in structure allows the vehicle to be described in terms of the topic (Genter & Markman, 1997). In short, metaphors enable learners to notice common relationships between the topic and vehicle beyond the physical object in which the relations are embedded (Genter & Clement, 1988). Thus, elements are mapped based on corresponding relational structures that are more thematic rather then attributional or elemental, and comprehension requires learners to compare the topic to the vehicle in order to find corresponding properties (Genter & Clement, 1988). Therefore, the objects of the two concepts do not have to resemble each other
because when presented with a metaphor learners seek the common relations between the concepts which the objects represent.

Another approach to metaphor comprehension is the attributional hypothesis (Glucksberg & McGlone, 1999), which proposes that learners comprehend metaphors by searching and selecting corresponding attributes found between the vehicle and topic. With this model, the vehicle provides access to the category that will give meaning to the topic and at the same time the topic constrains the breadth of the category. Thus, according to the attributional model a metaphor should make certain aspects of the information to be learned stand out over other information (Glucksberg & McGlone, 1999). However, the two approaches to metaphor comprehension may be more complementary rather than competing. The type of metaphor used may also determine which approach best explains its’ comprehension. Metaphors can be grouped into categories of relational metaphors, attributional metaphors and a combination of the two (Genter & Clement, 1988). Thus, Shen (1999) proposes a hybrid model for metaphor comprehension mixing the principles used for interpreting metaphors with both relational and attributive methods.

Genter and Clement (1988) performed a series of experiments examining four different approaches to the interpretation of metaphors. Their findings revealed strong support for the structure-mapping hypothesis. Learners appeared to search for relational commonalities significantly more then attributional information, even when the metaphors were designed to suggest both attributive and relational interpretations (Genter & Clement, 1988). Though the structure-mapping hypothesis is a good explanation for many metaphors it does appear to have one severe drawback. What the hypothesis fails to
account for is the cognitive context of the learner and their goals. Despite differences in interpretation, metaphors restrict the transference of elements from the topic domain to the learner’s internal representation. This occurs through the metaphor activating a certain schema which the learner uses to build such representations (Simpson & Pellegrino, 1993). Although this provides a nice explanation for understanding how learners may interpret metaphorically derived themes and effective guidelines for portraying them graphically what we do not know is how metaphors influence learning.

Learning and Metaphors

Metaphors have been shown to influence a range of learning domains such as marketing education (Weinrauch, 2005), second language development (Littlemore & Low, 2006), mathematical competence (Mayer & Moreno, 1999; Leher, Storm, & Confrey, 2002), computer interface design (Hsu & Schwen, 2003) and scientific concepts (ChanLin, 1996). McKay (1999b) conducted an experiment in order to investigate whether presenting learners with a text and a textual metaphor or a text and a graphical metaphor differentially influenced the learning of programming concepts. Specifically the author was interested in whether or not the two presentation modes differentially influence learning outcomes in students with different cognitive styles (imagery vs. verbal). In an earlier study, McKay (1999a) found that learning outcomes for students using text-based materials enhanced with graphics were affected by an interaction of the presentation format and the learner’s cognitive style. Thus, the author suggests that matching presentation formats with a learner’s cognitive style should enhance learning outcomes. Specifically, that verbalizers should perform best with a graphical metaphor.
and imagers should perform best with a textual metaphor McKay (1999b). The findings revealed that between the verbal and imagery cognitive styles learning outcomes with graphical metaphors were best for learners with a verbal cognitive style. However, those learners’ within the imagery cognitive style group also performed best with the graphical metaphor rather than the textual metaphor, which was contrary to the author’s prediction McKay (1999b). Thus, presenting metaphors visually appears to positively influence learning outcomes over textual metaphors regardless of cognitive style. These findings are important because it shows that metaphorical graphics promote learning by enabling learners to access new theme related information and integrate it with prior-knowledge when creating problem solutions McKay (1999b).

Studies using thematic maps have also shown promising results for learning outcomes. Thematic maps are able to display distributions of different attributes across a reference map. For example, they can be used to display populations, income, and agriculture (Rittschof et al., 1994). Because thematic variables can be depicted in a variety of ways, they allow for the examination of the influence of structure and feature information on memory for text (Rittschof et al., 1994). Structural information provides a spatial reference for locating the different attributes on the map. Therefore, encoding structural information is essential because the visual characteristics promote the encoding of abstract structural information (Rittschof et al., 1994). In other words, for thematic maps structural information tells the learner where it is. Conversely, feature information involves attributes such as detail, shape, size, and color which are used to make the discreet features visible. Feature information allows learners to differentiate between the different structures and promotes memory by elaborating on the information being
encoded (Bradshaw & Anderson, 1982). Thus, feature information tells the learner where it is. A study by Rittschof, Kulhavy, Stock, and Hatcher (1993) had students view one of three thematic maps depicting the island of Ceylon and then read a text containing facts about the themes. Overall it was revealed that learners recalled more facts related to the specific theme depicted on the map and answered more inference questions based on the maps theme then learners who received a map displaying a different theme. However, it was inconclusive as to whether the increased performance on transfer questions was due to learners selecting the relevant structural information depicted on the map or because the thematic map primed and directed learners attention to the text facts that corresponded to the specific theme viewed (Rittschof et al., 1993). A follow up study by Rittschof et al. (1994) investigated the effect of verbal priming on learners’ ability to recall related and unrelated theme facts when presented with a thematic map and a text passage. The experimental groups received one of four thematic maps: a proportional map, a cartogram, a data map, or a choropleth map, while the control group received a data table. Learners were presented with either the map first or the text first and were primed or not primed for theme related knowledge. Three different themes were present in the text (agriculture, rainfall, and elevation) while only one of the themes was depicted by the map. Learners were then tested on their recall of text facts and their ability to make theme related inferences. Their results revealed that when receiving the map first learners recalled significantly more theme related and unrelated facts. On the other hand, verbal priming did not appear to direct the learners’ attention to theme related facts or improve their ability to make theme related inferences. However, those who did receive the verbal prime recalled fewer unrelated theme facts then those learners who did not receive a
verbal prime (Rittschof et al., 1994). A further study (Rittschof & Kulhavy, 1998) examined if students recall of theme related information was differentially influenced by either a thematic map or a non-thematic map. Learners were presented with one of two types of thematic maps: a cartogram or a choropleth, or one of two data tables. The authors predicted that recall for theme related facts would be greater than non-related facts. Results revealed that learners’ did show a greater recall for related text facts over unrelated text facts. However, thematic maps did not affect recall differently then the data maps. Thus, the thematic maps abstract depiction of numerical values did not show an increase in computational efficiency over data maps (Rittschof & Kulhavy, 1998). What these findings do suggest though is that metaphors can be effectively displayed across different types of graphics and that the facilitative effects of using multiple representations are present when using thematic displays. Furthermore, a study by Schwartz et al. (2006) examined the influence of metaphorical priming on learners’ comprehension of concepts when learning a problem-based subject. The authors suggest that when new information is presented within the context of some pre-existing knowledge learners are more likely to activate that prior-knowledge, which will facilitate the organization of new information into the existing schema leading to improved learning outcomes for comprehension (Schwartz et al., 2006). Furthermore, the authors propose that the structure of the metaphor is ideal for activating prior-knowledge and facilitating the organization of new information. In other words, the use of metaphors is a way in which relevant connections can be made within a pre-existing domain of knowledge (Schwartz et al., 2006). Thus, the authors wanted to determine whether learners, when primed with relevant metaphors during learning, show an increase in
comprehension as compared to receiving an irrelevant metaphor or none at all. Moreover, the learner’s interpretation of a familiar metaphor should be accessible and processed in parallel with the learning material thus making them computationally efficient (Schwartz et al., 2006). Therefore, if a relevant metaphor is used to prime a learner’s prior-knowledge the metaphor may serve as both an interpretative and organizational vehicle for establishing an understanding of the learning material (Schwartz et al., 2006). The authors suspect that priming students will help promote the benefits of relevant metaphors on comprehension. They also believe that a metaphor which enables learners to keep a domain in mind will help them to construct meaning from the learning information. They hypothesize that learners will learn more when they are primed with a relevant metaphor compared to no metaphor at all. They also hypothesize that learners will learn more using a relevant metaphor rather then an irrelevant metaphor. The metaphorical primers used in the study consisted of a series of questions used to summon domain knowledge among the students. Relevant metaphor questions involved questions about family, while irrelevant metaphor questions dealt with the learners experience playing games. The findings revealed that metaphorical priming did not influence surface level retention of the information (Schwartz et al., 2006). However, the results did reveal that using a relevant metaphor during learning facilitates the learners’ deep comprehension and personal understanding of the topic significantly better then receiving either an irrelevant metaphor or no metaphor at all. More importantly, this study provides evidence that presenting learners with a relevant metaphorical primer, rather than an irrelevant metaphorical primer, increases the learners’ ability to access prior knowledge, which enables them to give higher quality responses when answering questions. Thus, the
computational efficiency of learners’ cognitive processes appears to be greater when the priming is relevant to the learning task. Furthermore, the metaphorical ground that provided the context in which learners could create knowledge about the topic only influenced responses that reflected knowledge summoned by it (Schwartz et al., 2006). Therefore, students who learned the material within the context of the relevant metaphor were better able to provide higher quality responses on all quality measures. This suggests that students were integrating the knowledge activated by the relevant metaphor with the new information provided by the learning material, which is an indication of deep level processing (Schwartz et al., 2006; Mayer & Moreno, 2003; Schnotz, 2002). Overall, the findings suggest that priming learners with a relevant metaphor leads them to actively engage in the learning material and to integrate what they are learning with relevant prior-knowledge. These findings are important because they inform us that the priming of learners for schema relevant to the topic facilitates learners’ comprehension of the information. We know that relevant metaphors facilitate deep comprehension because they enable learners to actively process new information, what we do not know is how metaphors may influence learners’ mental models.

Mental Models and Metaphors

Mental models are structures of knowledge made up of individual propositions that consist of objects, and relationships between objects (Staggers & Norcio, 1993). Mental models are organized by both categories and relational properties that reflect domain-specific knowledge structures in memory. Thus, a mental model is a learners’ internal representation of a domain constructed with prior knowledge and
current learning (Wilson & Rutherford, 1989). The construction of mental models has been shown to benefit multimedia learning environments over single media presentations (Glenberg & Langston, 1992). Numerous studies have demonstrated that learning from text and graphics facilitates deep comprehension (Mayer & Gallini, 1990; McKay, 1999a; Mayer et al., 2005) but not verbal recall (Mayer, 1989). Thus, the findings of these studies suggest that creating complex mental models is facilitated by referent connections between the two information sources, rather than separate non-interactive mental models for the respective depictive and descriptive representations. Furthermore, the construction of mental models is consistent with the model for text and graphic integration (Schnotz & Bannert, 2003) and the cognitive theory for multimedia learning (Mayer & Moreno, 2002, 2003). The use of graphics such as diagrams and maps facilitates both representational and referential connections (ChanLin, 1996). Representational connections refer to the comprehension of verbal information in response to information in the depictive system and referential connections refer to memory units in the descriptive system corresponding to memory units in the depictive system (ChanLin, 1996). On the other hand, the use of metaphors in multimedia not only promotes representational and referential connections, but associative connections as well. Associative connections refer to memory units of the descriptive and depictive systems being interrelated (ChanLin, 1996). Thus, memory units in either the depictive or the descriptive systems can trigger memory units within and between processing systems. Therefore, the addition of metaphors to multimedia learning enables learners to make more connections and possibly increase comprehension.
Prior-knowledge also plays an important role in learning when using metaphors. Studies have shown that prior-knowledge of content domain can influence the type of inferences that learners’ draw from the material (Kushnir & Gopnik, 2007; Best, Rowe, Ozuru, & McNamara, 2005; Gilabert, Martinez, & Vidal-Abarca, 2005). ChanLin (1996) showed that when learners were presented with a metaphor that was unfamiliar, they were distracted by the metaphor and performed at a lower level. Thus, it is important for metaphors to be highly recognizable and therefore easily interpretable for them not to be detrimental to learners. Furthermore, since prior-knowledge of a metaphor influences learners’ inferences it can be assumed that the learners mental models, constructed from thematic graphics, will be very different in their structure because of differences in prior-knowledge.

The model for the integration of text and graphics (Schnotz & Bannert, 2003) and the cognitive theory of multimedia learning (Mayer & Moreno, 2002, 2003) have provided us with a good framework for understanding how and why learners benefit from a combination of graphics and text. Moreover, the pervasiveness of metaphors in communication and the ability to convey positive and negative themes through metaphorical graphics suggest that using such graphics could be an effective learning tool. Thus, it was expected that the learners’ interpretation of the theme, derived from the metaphorical graphic, would influence what the learner recalled from the text. Furthermore, we expect that priming learners’ for the content domain will facilitate the activation of relevant prior-knowledge when presented with the thematic graphic and thus promote the organization of coherent mental models. Finally, we expect that the learners’
mental models will be structurally different from one another because learners differ in their prior-knowledge and thus will learn different things from the text.

The Present Investigation

In the present investigation, we used four different graphics, all depicting flowers: two graphics depicted growing flowers representing a positive or nurturing theme and two depicted dead flowers representing a negative or degenerating theme relative to an accompanying passage. Furthermore, each type of graphic was set within either a literal or figurative context: the literal context displaying flowers in a vase sitting on a table within a room and the figurative context displaying the same flowers, but in a context made to appear more symbolic. The text consisted of a familiar topic (e.g., romantic relationships) in order to enhance the likelihood that learners possessed some prior knowledge of the content. Furthermore, the text was written so that it contained both positive and negative information about romantic relationships so that it was consistent with one of the two graphic themes.

We expected that the graphic’s theme would accentuate one of the two theme-related perspectives found in the text and evoke the use of prior knowledge that was consistent with the graphic’s theme. Specifically, we expected that the growing graphics would emphasize the positive aspects of romantic relationships described in the text and would activate knowledge consistent with that theme; alternatively, we expected that the dying graphics would emphasize the negative aspects described in the text and would activate knowledge consistent with a dying or degenerative theme. We further expected that the literal context would constrain the learner’s interpretation of the text by
suppressing knowledge that was inconsistent with learners’ interpretation and that the figurative context would fail to suppress inconsistent information but would allow learners to draw on a broader range of prior knowledge about the subject. In short, we expected that the learners’ cognitive interaction with the thematic displays would activate relevant prior knowledge and influence learners’ interpretation of the image and subsequent comprehension of the passage.
CHAPTER III

METHOD

Design

Two factors, Graphic Theme and Graphic Context were combined to yield four experimental cells. The resulting design was a 2 Graphic Theme (Growing vs. Declining) × 2 Graphic Context (Literal vs. Figurative) between-subjects design.

Participants

Fifty-nine undergraduate volunteers were randomly sampled from a midsize western university. Of the total, 44 subjects were women and 15 were men. Participants were primarily white, middle-class students with a mean age of 20.7 years, with no apparent sensory or learning disabilities that would preclude their participation in the investigation. Each participant was randomly assigned one of the four experimental conditions, with approximately equal proportions of each sex distributed in each cell.

Materials and Instruments

Experimental Website

The experimental website was a 28-page hypermedia environment consisting of four pages of introductory material, 11 “wait” pages, and 13 pages of instructional text and graphics. The introductory information consisted of an informed consent, general instructions, demographic data sheet, and a page to route participants to one of the four
The experimental website was divided into six sections. Section 1 consisted of a Microsoft Word document titled Response-Essay 1. Section 2 was an interpolated math task consisting of six math problems. Section 3 consisted of a Microsoft Word document labeled Response-Essay 2. Section 4 was a word recognition task. Section 5 consisted of a bipolar 7-point Likert rating scale measuring participants’ perception of the general valence of the passage, with 1 = extremely negative, 4 = neutral, and 7 = extremely positive. Section 6 consisted of a 10-point Likert rating scale measuring participants’ aesthetic perception of the four experimental graphics.

Demographics

The demographic data sheet was used to assess the demographics of the participants, sampling age, GPA, gender, class standing, and their current relationship status—single, married, committed but not married, etc. Another seven questions were included to assess the participants' feelings and attitudes towards their previous and current romantic relationships. The questions sampled: (a) their current relationship satisfaction, (b) the seriousness of their most recent relationships, (c) the temporal longevity of the most recent relationship, (d) the elapsed time between their most recent and current relationship, (e) their current feelings relative to the dissolution of their last relationship, (f) their current perception of their feelings at the time of the dissolution of their last relationship, and (g) their current perceptions of the quality of their last relationship. All questions were measured on a 7-point bipolar Likert scale, with the poles labeled by appropriate one- to two-word verbal designations.
Experimental Graphics

Four experimental graphics were designed for the investigation, with each graphic varied along two dimensions: theme and context. The theme of the graphic was defined as an aggregated set of features, comprising as a whole a generalized unifying or dominant concept or idea conveyed as a unitary display. One of the themes referred to the concept of growth and development; the other referred to the concept of death and dying. When the theme conveyed was the concept of growth, the graphic displayed a bouquet of flowers in full bloom; when the theme was conveyed by the concept of death, the graphic displayed the same bouquet of flowers, but this time wilted and dead. The context of the graphic was defined by the metaphorical intensity of the displays. When the metaphorical context was strong, the graphic conveyed a figural representation of the theme; when it was weak, the graphic conveyed the theme as a literal pictorial representation. All four graphics were shown in color and were of the same dimensions, measuring 5.4” x 4.0”.

The figural and literal displays are shown in Figures 1-4, for the concepts of growth and death, respectively.

**Graphic Norming.** In order to ensure that the two themes (i.e., growth and development, and death and dying) were appropriately represented in either of the two displays, 34 undergraduates normed each of the graphics for verbal descriptors likely to be consistent with the concepts of growth and development or and death and dying for the corresponding theme display. Thus, 30 descriptors were sampled from a thesaurus of English words, fifteen of which conveyed a positive valence associated with growth, and fifteen conveying a negative valence related to death. The growth/development and death/dying terms are shown in Table 1.
Figure 1. Literal growing.

Figure 2. Figurative growing.
Figure 3. Literal dying.

Figure 4. Figurative dying.
Table 1

*Thirty Descriptors Consistent with the Concepts of Growth/Development and Death/Dying*

<table>
<thead>
<tr>
<th>Growth Descriptors</th>
<th>Death Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blissful</td>
<td>Bleak</td>
</tr>
<tr>
<td>Cheerful</td>
<td>Cheerless</td>
</tr>
<tr>
<td>Delighted</td>
<td>Dark</td>
</tr>
<tr>
<td>Elated</td>
<td>Dismal</td>
</tr>
<tr>
<td>Exultant</td>
<td>Downcast</td>
</tr>
<tr>
<td>Gleeful</td>
<td>Dreary</td>
</tr>
<tr>
<td>Happy</td>
<td>Forlorn</td>
</tr>
<tr>
<td>Jolly</td>
<td>Gloomy</td>
</tr>
<tr>
<td>Jovial</td>
<td>Heavyhearted</td>
</tr>
<tr>
<td>Joyful</td>
<td>Joyless</td>
</tr>
<tr>
<td>Jubilant</td>
<td>Melancholic</td>
</tr>
<tr>
<td>Lighthearted</td>
<td>Morose</td>
</tr>
<tr>
<td>Merry</td>
<td>Sad</td>
</tr>
<tr>
<td>Upbeat</td>
<td>Sorrowful</td>
</tr>
<tr>
<td>Uplifted</td>
<td>Sullen</td>
</tr>
</tbody>
</table>

The 30 descriptors were factored using a principal components analysis with varimax rotation. The analysis yielded two factors accounting for 73% of the total
variance. Factor one was comprised of 14 descriptors conveying an uplifting theme of development and growth, and factor two was comprised of 12 descriptors and conveyed a sorrowful and melancholy theme of death and dying. The remaining four descriptors failed to contribute to either factor one or two, using a cutoff coefficient of .40, and were dropped from subsequent analyses. Mean ratings of the 14 and 12 descriptors were computed for the growing and dying factor themes, respectively. Undergraduates rated each of the four graphics for both themes. Thirty-four undergraduates rated the literal graphics, and 16 undergraduates rated the figural graphics. With the means tested using a two graphic X two rating theme within-subjects design, for each graphic context, respectively. The analyses yielded significant interactions for both tests, $F(1, 16) = 190.23$, $MS_{err} = 1.68$, $p < .01$ and $F(1, 16) = 94.23$, $MS_{err} = 1.36$, $p .00$, with the figurative growing graphic yielding a growing theme rating of $M = 3.99$ and a dying theme rating of $M = 1.81$, and the figurative dying graphic yielded a growing theme rating of $M = 1.46$, and a dying theme rating of $M = 4.77$. As for the literal graphics, the means were: Growing Graphic Growing theme, $M = 5.98$; Growing Graphic, Dying theme, $M = .79$; Dying graphic growing theme, $M = 2.63$; and Dying graphic dying theme, $M = 3.57$. In short, growing graphics conveyed a growing theme, and dying graphics conveyed a dying theme, for each of the graphic contexts.

**Experimental Passage**

The experimental passage was a 570-word narrative describing positive and negative qualities indigenous to romantic relationships. The passage was comprised of 28 sentences, half of which addressed positive attributes of relationships, whereas half addressed attributes of relationships that were negative. Positive attributes were defined
as explicit statements projecting a hopeful and/or favorable perspective, agreement, tone, or approval. Negative attributes were defined as explicit statements that projected pessimism, unpleasantness, or a perspective that was disagreeable. Attributes were differentiated at the sentence level, with each sentence either positive or negative, and never a combination of both.

In order to ensure that the valence of the attributes of the experimental passage was properly assigned, a three-stage procedure was employed. In the first stage, two sources were selected: a text on communication and relation maintenance (Canary & Stafford, 1994) and a text on close relationships (Weber & Harvey, 1994). From these sources, material on romantic relationships was sampled. The sample resulted in 32 separate sentences, sixteen each of positive and negative relationship attributes. In the second stage, ten students (five graduates and five undergraduates) identified the attribute category of each sentence in order to ensure that equal numbers of sentences described either the positive or negative attributes. A sentence was deemed positive or negative, respectively, if it was assigned to a category by 100% of all raters. The results of the assignments yielded 28 unanimously rated sentences, half positive and half negative. In the third stage, it was essential to norm the sentence attributes on the participant population on whom the experimental data were sampled. Thus, using a 7-point Likert scale (7 = positive definition; 1 = negative definition), each sentence was rated by 16 undergraduates for the degree to which the sentence was viewed according to its respective definition. Results from the ratings revealed a mean rating of positive, $M = 4.05$ and negative attributes, $M = 4.07$, respectively.
Procedure

Participants completed all procedural tasks in a university computer lab, at individual computers, in groups ranging from 1 to 20. Participants were invited to sit at a computer of their choice, where the screen was set to the informed consent page, and the experimental condition to which they would be exposed was randomly assigned. All instructions during the procedure were read aloud by the proctor while participants read quietly to themselves. If participants chose not to participate, they were excused.

Students who agreed to participate were directed to click the ‘next’ button which led them to a page that instructed them on general information on how to complete the study, including where to find further instructions and assistance. The instructions informed participants that they would be reading an essay on romantic relationships and would be asked to write an essay based on what they read.

After all questions were answered, participants were directed to click the ‘next’ button, which led to the routing page. There, they were randomly directed to select one of the four routing page options and read the experimental passage and the corresponding graphic displayed there.

Participants were allotted 7 minutes to read the passage and view the experimental materials. When time expired, they were instructed to click the ‘next’ button, which advanced them to a 1-minute interpolated math task, followed by the essay instructions. Following the instructions, they were allotted 12 minutes to write their essay. The essay instructions directed the participants to explain what they had learned from the passage that may have influenced or informed their perspective on romantic relationships, feeling free to be as elaborative and generative as they wished.
Next, two rating tasks were introduced. First, participants were asked to re-read the experimental passage and rate it on a 7-point Likert scale from extremely positive to extremely negative. Second, they were asked to view, again, the graphic that was presented in their respective condition and rate it on a ten-point Likert scale from extremely ugly to extremely beautiful.

The procedural sequence concluded with the debriefing page after which participants were thanked and excused.
CHAPTER IV

RESULTS

Data Source

Participant protocols were scored for the number and type of statements students wrote in their essays. Statement types were personal, non-personal, emotional, or informational regarding romantic relationships. Personal statements were defined as knowledge brought from the mind of the learner that was a personal experience, event, or activity that was not present in the experimental passage. Non-personal statements were defined as knowledge brought from the mind of the learner that was an evaluative belief, judgment, or opinion, that was not a personal experience and was not present in the experimental passage. Emotional statements were defined as knowledge brought from the mind of the learner that was emotionally charged, as referenced by the learner’s choice of words and/or punctuation. Information statements contained content that was present in the experimental passage. All the statements from each category were assigned to one of three valence classes—positive, negative, or neutral. Positive statements were defined as an explicit statement or expression that projected a hopeful and/or favorable attitude, agreement, tone, or approval. Negative statements were defined as an explicit statement or expression that projected pessimism, unpleasantness, or a disagreeable attitude. Neutral statements were expressions that were neither positive nor negative.
Statement type and valence class were derived inductively using an open coding approach based on principles of grounded theory. Specifically, the statements were assigned to one of the categories above based upon the degree to which they were an exemplar of the conceptual domain underlying the categories. Since essays were written twice it was important to determine the extent of change from essay 1 to essay 2 regarding the presence of statement type relative to the total number of statements produced. Therefore, difference scores for each statement type were converted to proportions in order to determine how much was produced relative to the total number statements. Thus, difference proportions were entered into the basic experimental design as dependent measures, with statistical significance evaluated at an alpha level equal or below .05

**Experimental Analyses on Information Derived from the Passage**

The number of statements containing only passage content relative to the total number of statements made were entered as proportions into a 2 Metaphorical Theme (Growing vs. Declining) × 2 Graphic Context (Figurative vs. Literal) × 3 Statement Valence fixed-factor analysis of variance, with repeated measures on the statement valence variable. The analysis revealed that neither the main effects nor interactions reached an acceptable level of statistical significance.

**Experimental Analyses on Statements Emerging from Mind**

Difference scores in the number of statements students brought from mind from Essay 1 to Essay 2, relative to the total number of statements made, were entered as proportions into an analysis of variance like the one described above. Three separate
analyses were calculated, one each for each of the three types of statements in this category—non-personal, personal, and emotional.

For the non-personal statements, the analysis revealed a significant interaction between graphic set and statement valence. \( F(1,76) = 3.99, \text{MSE} = .245, \ p < .049, \) Cohen’s \( d = .19 \). Specifically, students reading the passage in the presence of either of the two figurative graphics added on average 10.6% more non-personal statements of a positive nature from their first to their second essay. However, there was a concomitant mean reduction of 16.5% for non-personal statements that were neutral (Figure 5). All tests on the personal and emotional statements failed to reveal significant variation.

![Figure 5. Non-personal statement interaction: Graphic set × statement valence.](image)
Prediction Equations for Experimental Conditions

Since the passage theme was targeted toward a discussion of romantic relationships, we reasoned that learners' experience in their own personal relationships would be differentially influenced by the experimental graphics accompanying the text. We were interested in the degree to which these experiences in personal relationships would influence both the amount of information learners derived from the passage, and the proportion of information they brought from mind after reading the passage. We were also interested in learners' ratings of the extent to which they perceived the graphics as aesthetically pleasing because aesthetics have been implicated in learners' reactions to visual stimuli. And, of course, we needed to determine the extent to which learners' perception of the passage valence was operating as well. Aesthetic ratings were made by requiring learners to judge the beauty of the graphic they viewed on a 10-point Likert scale, with 1 = extremely ugly, and 10 = extremely beautiful. Passage ratings were determined by requiring learners to rate the passage on the extent to which it appeared to them as more positive or negative in its valence, with 1 = extremely negative, and 7 = extremely positive. Thus, we tested the extent to which the relationship, passage, and aesthetic variables predicted each of the four statement types under each of the four graphic conditions. We expected the graphics to differentially influence these prediction equations.

Finally, prior to the test of these equations, it was essential to determine that learners did not differ in their aesthetic judgments across the four graphic conditions. Therefore, aesthetic ratings were entered into a 2 Metaphorical Tone (Growing vs.
Declining) \times 2 \text{ Graphic Set (Figurative vs. Literal) fixed analysis of variance. The analysis revealed that learners judged the aesthetic value of the graphics equivalently across all graphic groups—metaphorical tone, } F (1, 79) = .33, \text{ MSerr } = 3.09, p = .57; \text{ graphic set } F (1, 79) = 1.17, \text{ MSerr } = 3.09, p = .28; \text{ and metaphorical tone x graphic set interaction, } F (1, 79) = .33, \text{ MSerr } = 3.09, p = .57.

\textbf{Predicting Passage Information.} In the first analysis, the predictors: current relationship satisfaction, seriousness of last relationship, length of last relationship, months passed since last relationship, current feelings regarding break-up of last relationship, feelings at time of break-up, and perceptions of the quality of the last relationship were entered into a step-wise multiple regression equation predicting the proportion of positive statements learners wrote after reading the experimental passage under each graphic condition. The analysis revealed that the learners reading the passage in the presence of the figurative graphic depicted in a growing metaphorical tone wrote fewer positive statements in their essay, if they judged the graphic as aesthetically pleasing, } t = -2.80, b = -.57, p = .01, \text{ accounting for 33\% of the variance. As for the negative statements learners wrote in their second essay, the second regression analysis revealed that the seriousness of their previous relationship was the significant predictor, } t = -.2.83, b = -.59, p = .01, \text{ accounting for 30\% of the variance, but only under conditions when they saw the growing graphic in the literal context. Specifically, the more serious learners' previous relationship, the fewer negative statements they included in their essay after reading the passage in the presence of the growing literal graphic. Finally, the third regression analysis revealed that learners who perceived the passage more negatively generated proportionately more neutral statements, but only in the presence of the}
growing literal graphic, $t = -2.51, b = -.54, p = .02$. This predictor variable accounted for 30% percent of the variance.

**Predicting Information from Mind.** Again, the predictors were entered into a step-wise multiple-regression equation for each type of statement and its valence class. In the first analysis, the proportions of personal statements of a positive nature made by learners from the first to the second essay were regressed on the predictors. The analysis revealed that when learners read the passage in the presence of the figurative growing graphic the seriousness of their last relationship significantly predicted 23% of the personal positive statements they made, $t = 2.16, b = .48, p = .05$. In addition, when viewing the literal growing graphic, the valence with which they rated the passage was the significant predictor, $t = 3.88, b = .70, p < .01$ accounting for 50% of the variance. Specifically, learners in this condition who viewed the passage more positively included more personal statements of a positive nature in their second essay. In the second analysis, the number of neutral statements learners included in their second essay was significantly predicted in the declining figurative graphic condition based on the way they felt at the time of the dissolution of their last relationship, $t = 2.54, b = .54, p = .02$. In this case, the more positive feelings learners reported about the dissolution of their last relationship, the more personal statements of a neutral nature they included in their essay. This predictor accounted for 29% of the predicted variance.

In the next set of analyses, the proportions of nonpersonal statements for each valence class, respectively, were regressed on the predictors from the first to the second essay. In the first analysis, the seriousness of learners' last relationship significantly predicted 28% of the nonpersonal statements of a positive nature learners produced—but
only in the presence of the declining figurative graphic $t = 2.26, b = .53, p = .04$. In the second analysis, the extent to which learners perceived the passage as negative, the higher the proportion of nonpersonal statements they made of a neutral nature, $t = -3.17, b = -.63, p < .01$ but, this time, only in the presence of the growing literal graphic. The proportion of the predicted variance in this analysis was 40%.

Finally, in the last set of analyses, the proportions of emotional statements learners made from the first to the second essay were regressed on the predictors—again for each valence class of the statements. In this set, only emotional statements of a negative nature were influenced. Specifically, the analysis revealed that when learners perceived the declining figurative graphic as more beautiful, they were significantly more likely, $t = 3.17, b = .69, p = .01$, to produce a higher proportion of negative emotional statements in their second essay, compared to the first. In fact, 44% of the variance of these statements was predicted by the degree to which they found this graphic beautiful.
CHAPTER V

DISCUSSION

The goal of the present investigation was to determine if decorational graphics can function as thematic displays and influence learning outcomes when they are combined with textual material. Our results demonstrate that thematic displays can activate a learner’s schema of a topic, thereby creating noticeable differences in the type of prior knowledge they bring to mind while processing textual material. Furthermore, the type of prior knowledge that the learners incorporated into their essays about romantic relationships was distinctly different depending on which thematic display was viewed.

We assumed that even though the graphics appeared to be decorational in nature, the semantic relatedness between the graphics and text would cause them to act as thematic displays and therefore have a function beyond simple adornment as suggested by Carney and Levin (2002). In other words, we expected that the growing and dying graphics would activate different types of prior knowledge from the learners’ schema concerning the subject of romantic relationships even in the presence of the same passage, and our results confirm this assumption. Learners incorporated different types of theme-related prior knowledge into their essays depending on which graphic they had viewed while reading the passage.
Carney and Levin (2002) suggest that decorative graphics should neither influence the amount of information learners’ recall from the textual material nor the quality of information learners produce as a result of viewing such graphics. From a quantity perspective, our results generally support this claim. Our findings failed to yield significant differences in the amount of passage information learners used in their essays when describing what they had learned about romantic relationships. However, the type of passage information that the learners did include in their essays was influenced by the type of graphic they viewed and their prior knowledge of the subject.

Specifically, learners incorporated fewer passage statements, into their second essay, that were of a positive nature when they had viewed the graphic with the growing metaphorical theme in the figurative context. However, this was only true when they had judged the graphic as aesthetically pleasing. As Giora (1999) demonstrated context plays an important role in interpreting metaphorical meaning. Specifically, figurative contexts allow learners to evaluate a broader range of information when constructing meaningful associations between the visual content of the graphic and the verbal content of the text. Thus, the figurative context enabled our learners to broaden their interpretation of the graphic and text and in doing so the learners’ found it acceptable to incorporate information that was both consistent and inconsistent with the graphics theme, but which was still meaningful to their overall interpretation. In short, the figurative context did not suppress irrelevant information but instead allowed learners to evaluate, reflect upon, and incorporate a broader range of material into their essay resulting in fewer positive passage statements being included. Finally, though the result of the aesthetic judgment of the graphic appears counterintuitive at first glance, research has shown that aesthetic
pleasure is a result of the ease processing (Reber, Schwarz, & Winkielman, 2004) but does not influence how material is interpreted. Furthermore, beauty ratings are higher for graphics that leave stronger memory traces (Nadal, Marty, & Muner, 2006) and therefore, the aesthetic judgment of the graphic may reflect the ease in which the learner was able to process the graphic and its meaning but it does reflect nor influence how learners interpret the material or the type of information learners may incorporate into their essays.

Our results further revealed that learners who viewed the growing graphic in the literal context produced fewer negative statements from the passage, but only if they viewed their last romantic relationship as serious. In our investigation, the relationship between the thematic graphic and text subject was easily discernable and therefore should increase the likelihood that learners would activate and rely on their prior knowledge of the subject (Britton, Stimson, Stennett, & Gülgöz, 1998). Additionally, literal contexts function to constrain the type of information a learner attends to by suppressing irrelevant material (Keysar, 1994; Giora, 1999). Therefore, the literal context helped to suppress information that was inappropriate and while encouraging learners to extract information from the text, graphic, and their own prior knowledge that was relevant to the graphics theme. Furthermore, this finding only occurred when subjects viewed their last relationship as serious. This suggests that our learners’ were relying on their prior knowledge to help determine both the accuracy of their interpretation and which features of the text and graphic to include in their mental representation. In other words, for subjects who viewed their last relationship as serious, negative information contained in the passage was not appropriate to their interpretation and was therefore not incorporated
into their mental representation resulting in fewer passage statements of this type being included in their final essay.

Finally, learners who perceived the text as a negative reflection of romantic relationships included more neutral statements from the passage in their second essay, but only in the presence of the growing graphic in the literal context. Thus, for those learners the graphic and text were interpreted differently. The growing graphic conveyed a positive theme while the text conveyed a negative theme. Therefore, those learners’ who interpreted the passage as being negative discovered an inconsistency between their two initial interpretations that needed to be resolved. As Schnotz and Bannert (2003) propose, when learners are presented with a graphic and accompanying text they construct mental representations of each information source that reflect the individual’s interpretation of the material. Furthermore, the construction process results in the mapping of semantically related elements from each into a single representation (Schnotz & Bannert, 2003). This suggests that when the learners’ interpretation of the growing graphic was inconsistent with their interpretation of the passage the discrepancy had to be resolved in order to construct a coherent mental representation that included elements from both. We believe it is reasonable to assume then that during the process of constructing such a representation our learners continued to search for features between the graphic and text that were not incompatible with either interpretation. However, the literal context of the graphic serves to suppress material that is irrelevant to the meaning derived from the graphic. Therefore, learners may have incorporated neutral statements from the passage, rather then statements that were positive or negative in nature, as a way to mediate the discrepancy
resulting from the conflict, and this inclusion of neutral statements from the passage was a result of such processes.

As suggested by Lowe (2003) learning results in the construction of superior mental representations that incorporate, thematically pertinent information from explicitly presented sources with pre-existing knowledge structures. Thus, when combining textual material with thematic graphics the activation of the learners’ prior knowledge of the subject and the use of such knowledge is a very important component to the learning process. When looking at the proportion of statements between the learners first and second essays our results clearly show that the thematic displays influenced the type of prior knowledge learners relied on when reading and understanding the textual material. Learners made use of differently valenced personal, non-personal, and emotional prior knowledge when explaining what they had learned that influenced their perspective on romantic relationships. Thus, the text was influenced by the graphics through the type of prior knowledge learners summoned and incorporated into their response essays.

Specifically, those learners who read the passage in the presence of the growing graphic in the figurative context included more personal information that was positively valenced in essay 2 depending on how serious they viewed their past romantic relationship to be. In other words, the more serious learners viewed their past relationship to be the more personal information of a positive nature they included. Thus, the learners’ used their own personal experiences when evaluating the accuracy and plausibility of their interpretation of the graphic and text. Reading about romantic relationships activated learners’ schema of the topic and the positive theme of the graphic in
combination with the figurative context allowed learners to reflect upon various types of personal information. When constructing a coherent mental representation an important component of the process is incorporating prior knowledge into the structure (Schnotz & Bannert, 2003). Additionally, because figurative contexts facilitate the consideration of a broader range of information (Giora, 1999), it suggests that during the interpretation process learners assessed the accuracy of their interpretation by comparing it with their own previous experiences with romantic relationships. In other words, learners searched their own prior knowledge for features that either confirmed or disconfirmed their interpretation of the graphics theme with respect to the topic. Therefore, when the selected features from the learners’ prior knowledge confirmed their interpretation they included this personal information into their essay in order to support their beliefs.

Furthermore, when viewing the growing graphic in the literal context learners included personal information of a positive nature as a function of how positive they found the passage to be concerning romantic relationships. Here learners included more personal information of a positive nature when they found the passage to reflect a positive view of romantic relationships. Thus, the graphics literal context suppressed irrelevant information and directed the learners’ attention to information within their own prior knowledge that was consistent with the graphics positive theme. Therefore, the theme of the growing graphic and the literal context encouraged learners to attend to information that supported a positive interpretation of the subject matter. In short, learners included more personal information of a positive nature in their second essay when they found that their prior experiences and their interpretation of the text and graphic matched.
Conversely, those learners who viewed the declining graphic in the figurative context included more neutral information from their personal experiences as a function of their feelings regarding the dissolution of their last romantic relationship. In other words, when the learners had positive feelings towards the break-up of their last relationship they included more personal information into their second essay that was neutrally valenced. Thus, the learners correctly interpreted the theme of the dying graphic as being negative. However, because figurative contexts do not suppress information that is emotionally inconsistent (Giora, 1999), learners were able to reflect upon a wider range of information for inclusion into their mental representation. Therefore, when evaluating their experiences, in light of their interpretation of the graphic, those learners who retained positive feelings towards the dissolution of their last relationship found that their personal experience did not match their interpretation of the theme conveyed by the graphic. This inconsistency creates a conflict when constructing a mental representation that incorporates information from prior knowledge with elements from the explicitly presented sources. As Lowe (2003) points out superior mental representations are a result of incorporating information from explicitly presented sources with pre-existing knowledge. Therefore, when the learners’ past experience was remembered a being positive they included more personal information that was neutral in nature in order to mediate the inconsistency between their interpretation of the graphics theme and their own personal experiences.

Additionally, learners made use of non-personal information that was positively valenced when viewing the declining graphic in the figurative context but only when they viewed their last relationship as being serious. Because figurative contexts do
not suppress irrelevant and inconsistent information (Giora, 1999), learners were able to make use of, and reflect upon, a broader range of prior knowledge. The fact that learners included more non-personal information that was positively valenced when they viewed their last relationship as being serious, suggests that these learners used what they already knew about romantic relationship as way to evaluate the appropriateness of their interpretation of the graphics theme. Therefore, when their prior knowledge was not consistent with their interpretation of the graphics meaning the figurative context helped learners broaden their search to include more general knowledge of romantic relationships that was not personal in nature. In other words, when the learners’ interpretation of the graphics theme was inconsistent with their own personal experiences they relied upon general knowledge that was non-personal and positive in nature to explain and defend their views of the subject in their second essay.

Next, when viewing the growing graphic in the literal context learners produced more non-personal statements that were neutrally valenced but only when they found the passage to be negative. Here again we see an interplay between the theme of the graphic, the learner’s interpretation of the text, and their prior knowledge of the subject. When mapping visual-spatial information derived from the graphic with relevant semantic information derived from the text it is the learner’s prior knowledge of the domain that acts as a guide for selecting those features (Schnotz, 2002). Thus, since the mapping of elements between the two representations is schema driven learners used their knowledge of the subject to resolve the discrepancy they found between the text and graphic. Although literal contexts may help to suppress information that is inconsistent to the interpretation of the graphics theme it did not influence the way in which the passage
was interpreted. Therefore, the learners’ prior knowledge of the subject helped to mediate the discrepancy between the positive theme conveyed by the graphic and their negative interpretation of the text. However, it is not clear from the results why the learners relied on more general non-personal information rather than their own personal experiences to resolve this discrepancy. One possible reason is that autobiographical memories which include personal experiences often have a positive or negative valence attached to them (Rubin, 2005). Therefore, when learners searched for information to help resolve the conflict between their interpretations of the graphic and text they relied on non-personal information; and this in turn facilitated the resolution of the discrepancy and promoted a more coherent mental representation.

Finally, when learners read the passage in the presence of the declining graphic with the figurative context they included more emotional statements that were negatively valenced in their second essay but only if they found the graphic to be aesthetically pleasing. As mentioned before aesthetic pleasure is a result of how easily a graphic is processed (Reber et al., 2004) but does not influence what information is attended to nor how it is interpreted. However, negatively valenced pictures are more likely to arouse emotional memories regardless of attention and semantic relatedness compared to positively valenced pictures (Talmi, Schimmack, Paterson, & Moscovitch, 2007). Therefore, the combination of the thematic display and text activated the learners’ schema of the subject, and the negative interpretation of the graphics theme increased the likelihood that the prior knowledge learners reflected upon was emotional in nature. Therefore, learners were more likely to include emotional statements in their second essay when viewing the declining graphic compared to the growing graphic.
Conclusion

The present investigation examined the role of thematic displays in influencing learning outcomes of textual material. The results demonstrated that thematic displays are effective for conveying underlying themes present in textual material and it is the theme that helps cement the graphic and text together. Furthermore, because learners differ in their prior experiences the knowledge structures elicited by the thematic relationship of the graphic and text will also be different causing learners to process the explicitly presented information in accordance with what they already know. Additionally, the two contexts (literal and figurative) influenced both the range and type of information used for evaluating and interpreting the graphic and text. Therefore, the influence of the textual material is dependent upon the interpreted theme of the graphic and the context in which it is set along with learners’ prior knowledge of the subject.

The results of the present investigation provide two major findings relevant to thematic displays and the text which they accompany. First, the results further confirm Carney and Levin’s (2002) claim that certain types of graphics, such a decorational graphics, do not influence the amount of textual information learners are able to reproduce even when an overarching theme between the text and graphic is reliably conveyed. Secondly, and more importantly, the results demonstrated that thematic displays do influence the quality of learning outcomes by encouraging learners to independently reason about the subject by reflecting and evaluating the material in light of one’s own current knowledge and producing statements that reflect this process (Minbashian, Huon, & Bird, 2004).
However, the present investigation does have several limitations. First, the text constructed for this investigation was carefully created in order to ensure a systematic distribution of both positive and negative information regarding romantic relationships. In other words, the text was artificial in that it may not be representative of the type of information found in textbooks and other learning materials as well as how information is presented. Therefore, it is possible that the systematic manipulation of the information within the text had an influence of the outcomes as well. Furthermore, we chose the subject of romantic relationships because we expected our learners to have some pre-existing knowledge of the subject matter. In many cases, learners may have no knowledge of a subject and therefore it is unclear how a thematic display may influence the learning process in which they have no, or very limited, knowledge of the subject to be learned.

Secondly, the graphics we used in the present investigation were created and chosen for their easily identifiable theme and their obvious metaphorical relationship with the text subject. This was done so that interpretation of the graphics meaning required little cognitive effort on the part of our learners as well as increasing the likelihood that any influence they had on our learners’ cognitive processes would be noticeable. In addition, all the graphics used depicted flowers and therefore it is unclear if other visual content would be as successful acting as thematic displays. However, the type of graphic to be used in conjunction with textual material should always be carefully considered in light of the desired outcome, therefore we believe that it would be possible to successfully design thematic displays for a variety of texts.
Lastly, the semantic relatedness between the thematic display and the textual material was quite obvious and this may not be case in many learning situations in which multiple information sources are used. Thus, we are unable to determine if the results presented here would be similar to those in which the underlying theme between a graphic and text is not so noticeable. Therefore, it would be important for future research to use thematic graphics and text that are found in conventional learning materials in order to determine if they have a similar influence on learners’ cognitive processes.
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