

Enhancing L2 Reading Comprehension with Hypermedia Texts: Student Perceptions

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Abstract

This study extends current research about L2 hypermedia texts by investigating the combined use of audiovisual features including: (a) Contextualized images, (b) roll-over translations, (c) cultural information, (d) audio explanations and (e) comprehension check exercises. Specifically, student perceptions of hypermedia readings compared to traditional print texts are investigated in this study to address theoretical concerns that the combined use of multiple audiovisual annotations might split learners' attention from their reading comprehension. Additionally, student perceptions of the usefulness of the annotation features afforded by the hypermedia texts were investigated. Data were collected from 70 French language learners across four intermediate and advanced French courses at a large Midwestern research university. Participants in each course were assigned hypermedia readings, each of which being paired with an analogous traditional print reading of the same genre, with a similar word count and reading difficulty level, followed by a format preference survey. Results from data analysis of the format preference surveys showed statistically significant differences for user preference of the hypermedia texts and a user belief that the hypermedia format facilitated reading comprehension with less effort than print readings. Research findings about the reported usefulness of the annotation features are situated within Mayer's (2005) cognitive theory of multimedia learning. Directions for future research into the optimal design of hypermedia texts are discussed.

KEYWORDS: DIGITAL LITERACY; HYPERMEDIA TEXTS; READING COMPREHENSION

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Introduction

Many technological inventions have emerged since the industrial revolution, yet computer technology arguably remains the most radical innovation today. Despite speculations that the technological advancement which led up to the computer, including the radio and motion pictures, would come to replace traditional means of transmitting knowledge, Mayer (2005) argues that these technologies failed to address the brain and learning in the way that books and teachers combined can. Mayer's (2005) cognitive theory of multimedia learning (CTML) claims that when instructors use audiovisual materials designed according to the needs of the human brain, the technology plays a far greater part in bolstering learning. Following Mayer's (2001) *multimedia principle* that 'people learn better from words and pictures than from words alone' (p. 6), second language (L2) learners should experience increased reading comprehension of texts enhanced with hypermedia – interactive audiovisual features. However, before reading comprehension can be enhanced, the instructional design of hypermedia texts must take into account the brain's inherent information processing limitations of concurrent working memory (Sweller, 1988).

Previous L2 research has extensively examined the role of vocabulary familiarity in reading comprehension. Several studies (AbuSeileek, 2011; Chen and Yen, 2013; Dubois and Vial, 2000; Plass *et al.*, 1998; Yanguas, 2009) have examined the use of vocabulary annotation features in multimedia reading. However, there is presently a dearth of research on the additional audiovisual annotation features afforded by hypermedia – comprehension check exercises, pop-up cultural information and audio explanations – and no research examining these features used in combination with rollover translations and contextualized images. Accordingly, the authors in this study investigated students' perceptions of the use of hypermedia texts with multiple audiovisual annotation features compared to traditional print readings. The authors were particularly interested in the perceived mental effort learners claimed necessary to process the readings for each format, given the concern that the multiple affordances in the hypermedia texts could potentially split learners' attention from the content of the readings.

Theoretical Framework

During the past thirty years, numerous studies (e.g. Kim and Krashen, 1997; Laufer and Sim, 1985; Nation, 2001; Pulido, 2007) have provided evidence of direct correlations between reading activities and learner gain on measures of L2 literacy – vocabulary, grammar knowledge, spelling and increased reading comprehension proficiency. Reading comprehension involves constructing a mental representation from the content of the text for the purpose of

understanding the message (Mayer, 2005). In the case of L2 reading, difficult texts can be rendered comprehensible with gloss annotations in order for L2 learners with limited vocabulary mastery to construct a mental representation of the reading. Several researchers (Laufer, 1997; Pulido and Hambrick, 2008) claim an extant threshold of lexical knowledge for successful L2 reading comprehension. As noted by Nation (2001), textual glosses help provide access to authentic texts that would otherwise be too difficult for learners by providing accurate meaning of words that might be interpreted incorrectly. With sufficient word recognition, readers can allocate additional attentional resources required in text comprehension processes, such as constructing and integrating ideas from context, drawing information from long-term memory, monitoring comprehension and acquiring new vocabulary whose meaning was inferred from the context (Koda, 2005, 2007; Laufer, 1997).

In order to develop learners' vocabulary through reading, readers must first notice unfamiliar words deemed relevant enough for further processing. Learners can then deduce vocabulary meaning in the working memory using contextual cues with syntactic, semantic, and pragmatic knowledge from their prior knowledge, a process known as lexical bootstrapping (De Bot *et al.*, 1997). Ellis (2002) stated that there is a phenomenon of the rich getting richer for L2 vocabulary acquisition through reading while the poor readers with limited vocabulary development experience too much difficulty in following the meaning of the text to acquire new vocabulary words. However, multimedia instructional designers commonly seek ways to break this vicious cycle for struggling L2 readers by maximizing audiovisual features in computer assisted L2 texts in order to support lexical bootstrapping and to make difficult texts comprehensible.

Multimedia Research in Second Language Learning

According to Mayer's (2001) *multimedia principle*, providing learners both verbal (written or spoken) and pictorial images (illustrations, photos, or videos) should enhance the learners' ability to create coherent mental images in the working memory, ultimately increasing learning outcomes. Research on the use of hypermedia (interactive) glossary annotations – glossaries with textual definitions, translations or pictorial illustrations – often corroborated Mayer's multimedia principle. Findings from research on L2 reading comprehension and vocabulary learning with the use of multimedia texts claimed that annotations with both textual and visual information aided learners' more than textual information alone (Chun and Plass, 1996; Plass *et al.*, 1998). Research on memory and vocabulary recall in multimedia texts commonly found that students in a text-plus-picture annotation treatment outperformed those in text-only and picture-only treatments (Dubois and Vial, 2000; Yeh

and Wang 2003, Yoshii 2006; Yoshii and Flaitz, 2002). Yet some researchers (Sakar and Erçetin, 2004; Ariew and Erçetin, 2004) have found that despite students' favorable impressions toward pictorial annotations, there is evidence of little effect on reading comprehension. Mayer (2005) noted that 'one picture is not necessarily equivalent to 1,000 words' (p. 5). Anyone who has played the game *Pictionary*[®] can attest to the varied interpretations of the same visual stimuli. As summarized in findings by Yanguas (2009), textual translations help learners more than contextual guessing from images.

Similar to vocabulary acquisition research, it has long been noted that providing students access to vocabulary meaning via traditional glosses, electronic dictionaries, or hypermedia annotations supports L2 reading comprehension. An early study on vocabulary glosses found that students were able to recall significantly more details from an L2 reading when provided vocabulary meanings at the bottom of the page (Davis, 1989). AbuSeileek (2008, 2011) found that participants with access to a text using hypermedia annotations scored notably higher on reading comprehension tasks in comparison to their peers who read texts with no annotations. Yoshii (2006) found that text annotations in either the first or second language were both effective for vocabulary learning, although AbuSeileek (2008) found target language translations more effective in reading comprehension tasks. AbuSeileek strongly purports the use of target language glosses, limited to 3–5 words, placed immediately after the word to limit disruptions in reading. Glosses at the end of the page in print format texts are considered by some (AbuSeileek, 2008, 2011; Sakar and Erçetin, 2005) as less conducive to the concentration needed for reading comprehension than the instantaneous translations provided in hypermedia glossary annotations, such as the rollover translations in this study.

Research findings on the use of videos in instructed L2 learning contradict findings from other multimedia forms which corroborate multimedia claims that learning is supported with the use of both verbal (written or spoken) and pictorial images (illustrations, photos, or videos). In fact, studies on the use of L2 videos in instructed learning have commonly found evidence for a limit to the amount of information the working memory can process. Specifically, Sakar and Erçetin (2005) found that the learners in their study merely watched L2 videos and consequently made faulty inferences based on the visuals rather than the audio commentary. Thus, such findings suggest that the audiovisual input from the videos exceeded the learner's processing capacity for both visual and auditory input, and consequently, the learners relied predominantly on the visual input channel, ignoring the audio input, as they committed mental representations of the information to their memory. Sweller's (1988) cognitive load theory provides an explanation for learners' limitations while processing information during complex learning activities in

a theoretical model that illustrates the demands on the executive control of working memory. Drawing largely from Sweller's (1988) cognitive load theory, Mayer's (2005) cognitive theory of multimedia learning provides a theoretical model to inform multimedia instructional design by taking into consideration how the human mind works.

The Cognitive Theory of Multimedia Learning

Mayer's (2005) cognitive theory of multimedia learning (CTML) draws from three principles of human learning from the cognitive sciences: (a) The dual-channels assumption – human information processing systems include dual channels for visual/pictorial and auditory/verbal processing; (b) the limited capacity assumption – each channel has limited capacity for processing; and (c) the active processing assumption – active learning entails carrying out a coordinated set of cognitive processes during learning. The main idea of this theory is that learners cannot be held accountable for retaining information when bombarded with random unorganized facts even in both visual and pictorial forms. Rather, learners 'actively engage in cognitive processing in order to construct a coherent mental representation of their experiences' (Mayer, 2005: 6) based on what they paid attention to within a limited cognitive capacity. Critics of this theory often question if cognition is being mediated by something other than words and images, yet validity in this theory has been found over a wide range of circumstances (Reed, 2010).

Mayer's information processing model of a multimedia presentation (see Figure 1) shows how the brain first takes input from words or pictures in the sensory memory, then the working memory selects and organizes sounds and images and draws relevant information from the long-term memory (prior knowledge) for processing.

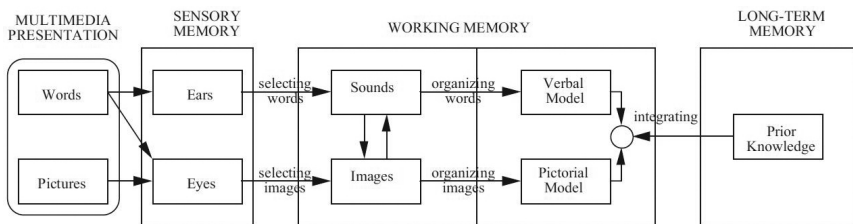


Figure 1: Mayer's (2005) Cognitive Theory of Multimedia Learning (p. 37)

Mayer's describes the outcome of *active learning* as the construction of a coherent mental representation of new information formed by the integration of both verbal and pictorial modes from the working memory with prior knowledge from the long-term memory. Thus, the synergistic benefit from

activating both verbal and pictorial models as suggested in the multimedia principle is limited by cognitive load restrictions in the brain's information processing (Sweller, 1988). In sum, Mayer's CTML states that multimedia learning is a demanding process that requires the learner to attend to and select the relevant material, organize the selected material into coherent verbal and pictorial representations and integrate these representations with prior knowledge. Thus, multimedia instructional materials should be designed to reflect an underlying understanding of how people learn, with attention to emphasizing relevant materials and reducing superfluous audiovisual stimuli.

Although L2 multimedia texts may provide audiovisual support to compensate for learners' limited mastery of vocabulary, too many stimuli may limit learners' ability to simultaneously select relevant information and form the mental images necessary to retain what they just read while approaching new information from the text in a reading task. Similarly, Mayer's (2008) multimedia *coherence principle* states that people learn better when extraneous material is excluded rather than included in a multimedia lesson. This is particularly important in L2 reading where research has found that learners are much more prone to distraction when they approach unfamiliar texts in their second language than in their first (Chang and Hsu, 2011). Distracted L2 learners may lose interest in texts as they stumble with reading comprehension, particularly with an authentic text situated in an unfamiliar socio-cultural context. Erçetin (2010) found through interviews with L2 learners that not understanding the text was the impetus for students' loss of interest in reading task. Rodrigo's (2011) findings corroborated Erçetin's point that understanding the text increases student interest in reading, and consequently fosters motivation to read. Reading comprehension check activities with multimedia hold the potential to provide immediate feedback to learners on the mental representation they have formed during their reading, encouraging the restructuring needed for learners to create an accurate mental representation of new information.

Various studies (AbuSeileek, 2011; Chang and Hsu 2011; Erçetin, 2010; O'Donnell, 2012; Pulido and Hambrick, 2008; Sakar and Erçetin, 2005) have identified the need for computer assisted language learning (CALL) reading materials to boost reading comprehension. Regarding the application of hypermedia for both vocabulary glosses and automatic comprehension questions, AbuSeileek (2008) remarked that as early as the 1980s, it was thought that hypermedia held promise in instructional settings. Several L2 reading researchers suggested the need for graded readers and structured activities (Pulido and Hambrick, 2008; Liburd and Rodrigo, 2012) like those provided in hypermedia texts to heighten L2 reading comprehension. Chang and Hsu (2011) also insisted on the need for CALL applications to foster L2

reading skills, albeit with some corresponding training sessions first to familiarize students with all their tools' capabilities. Erçetin (2010), in turn, specified a need for these kinds of tools, pointing out that low-knowledge learners showed a greater increase of knowledge than high-prior-knowledge learners when exposed to hypermedia-augmented reading passages. Similarly, Sakar and Erçetin (2005) also called for more hypermedia-based activities, insisting specifically on their implementation along with well-designed annotations. However, to date there exists a paucity of studies examining the use of multiple hypermedia text annotation features to contribute to an understanding of their optimal design.

In summary, reading in the target language is an important avenue for L2 acquisition. Computer assisted L2 reading materials with annotations providing visuals of unfamiliar situations, rollover translations of unknown vocabulary words, pop-up annotations to situate a foreign socio-cultural context via supplemental text or audio explanations provided by the instructor and interactive comprehension check exercises throughout the reading hold the potential of rendering authentic texts more comprehensible and accessible to L2 learners. This study responds to the many calls put forth to investigate L2 CALL reading materials by investigating student perceptions of the use of hypermedia texts compared to traditional print texts by responding to the following four research questions:

1. Which reading format do students prefer to learn the material, the hypermedia texts or traditional print texts?
2. Which reading format do students claim facilitates active learning (improved reading comprehension and increased critical reflection on the reading content)?
3. Which reading format do students claim require more effort to understand?
4. Which aspects of the hypermedia texts (images, rollover translations, cultural information, audio explanations or comprehension check exercises) did students find most useful?

Methods

In the spring of 2010, four intermediate and upper division French course instructors met with the Critical Reader (CR) hypermedia software designer (second author) to create hypermedia versions of texts taken from their course syllabus. Only select texts (Appendix A) with an analogous reading, of the same genre with a similar word-count and reading difficulty level, were considered for the study in order to create reading dyads – one electronic reading paired with an analogous traditional print. After completion of the dyadic

readings, a university evaluation and assessment specialist administered a format preference survey (Appendix B) in order to receive student feedback on their impressions of reading hypermedia texts compared to analogous traditional print readings.

Participants and Procedures

All of the participants in this within-subject design study were enrolled in one of four different undergraduate French courses – (a) Intermediate Language and Culture (20 students); (b) Introduction to Literary Analysis (12 students); (c) Introduction to Literature of Modernity (23 students); (d) Medieval, Renaissance, and Early Modern Civilization (25 students) – at a large Midwestern research university. Students in all four classes were provided password protected URLs to at least two hypermedia texts created by their course instructor. After the completion of all of the hypermedia texts and their analogous traditional print readings, an evaluation and assessment specialist administered a reading format preference survey during the last 20 minutes of each of the four classes. Of the 70 participants – 48 females and 22 males – who completed the format preference survey and background information questionnaire, 48 described themselves as French majors. The greater part of the participants (44) was underclassmen – 18 freshmen and 26 sophomores, 25 were upperclassmen – 15 juniors and 10 seniors and one was a graduate student.

Data Sources

The Critical Reader (CR) authoring software

The Critical Reader is a desktop authoring tool that provides a framework for integrating multiple media elements and web resources to instructional content that allow learners to interact with and explore course content, make decisions and receive corrective feedback. Figure 2 illustrates many of the CR's pedagogical affordances investigated in this study, including contextualized images, rollover translations, comprehension check exercises, cultural information and instructor audio explanations. The hypermedia texts contained multiple pages which students could navigate by clicking the forward arrow at the bottom of the screen. The left side of the screen contained a stationary segment of the text, and rollover translations, whereas the right side of the screen initially displayed a contextualized image of the text and the occasional comprehension questions. The image would be replaced with pop-up supplemental information (cultural information and instructor audio explanations) after users activated the highlighted hyperlinked areas (see Figure 2).

The screenshot displays a digital reading interface for Ronsard's sonnet 20. The text is presented in French with several words highlighted in yellow. Annotations are provided for these highlighted words: a callout box on the left indicates that clicking on the yellow text provides more information; a callout box on the right points to an image of Titian's 'L'enlèvement d'Europe' (1559-62), which is related to the text; and another callout box on the right points to a video player interface, indicating that an audio explanation is available for the highlighted text. The interface also includes navigation buttons for 'Page précédente', 'Page suivante', and 'Retour'.

Figure 2: A visual representation of the annotation features provided by the hypermedia texts

All of the hypermedia texts used in this study contained rollover translations – meaning the English translation would appear when the cursor hovered over hyperlinked words – for difficult terms that were deemed essential by the course instructor for a general understanding of the text. Each page of the hypermedia texts also contained images to provide a contextualized visual representation of the reading. Supplemental information to enhance learners' understanding of the socio-cultural and historical significance of the texts was also provided for the hypermedia texts: either in the form of a written explanation in the target language (approximately 1–6 sentences), or an explanation provided by the instructor in an audio recording. The instructor audio explanations were in the target language, and typically lasted 30 seconds to a few minutes. All of the hypermedia texts also contained comprehension exercises with immediate feedback to the students throughout the text. The students had two opportunities to answer the comprehension questions before being provided a correct response. Thus, students always had the possibility to submit correct responses to their instructor for course credit, an additional feature of the software.

The French readings

The 12 hypermedia texts in this study were created from pre-existing readings found on the course syllabus in the course textbook, reading packet, or required book. Of the 12 texts, there were six poems, five excerpts from short stories or novels, and one narrative (a personal interview from a French newspaper). Each hypermedia text for the poems and narratives had an analogous

paper reading of the same genre with a similar word-count and reading difficulty level (Appendix A). The novel hypermedia texts contained only one day's reading assignment from a book. The students read the remainder of the novel in traditional paper format.

Reading format preference survey and questionnaire

The format preference survey (Appendix B), designed by the second author, was intended to access students' perceptions of the usefulness of the CR hypermedia texts compared to traditional print texts and to collect participant background information. The survey started with seven reading format preference questions on a sliding scale with an image of the PDF print document to represent the traditional print texts on one side of the scale (-4 to 0) and the multimedia reader on the opposite side (0 to 4). The seven survey questions repeated the same visual (Figure 3), directing students to rank the strength of their opinions with a circle on the sliding scale of -4 to 4.

In order to respond to the first research question concerning student reading format preference, Survey Question 6 asked student preference directly. In addition, Survey Question 2 triangulated student format preference for learning the material by asking which format motivated students to learn the material. In order to respond to the second research question concerning student perceptions of which reading format better facilitates active learning, Survey Question 1 asked students which format enabled them to better comprehend the content of the reading, Survey Question 3 asked which format stimulated reflection on the reading's content, and Survey Question 4 asked which reading format helped read difficult texts more critically. In order to respond to the third research question regarding the effort students perceive as required to understand the reading, Survey Question 5 asked which format required more mental effort to understand the content of the reading and Survey Question 7 asked which format required more time involvement to read the text. In order to respond to the fourth research question concerning the usefulness of the hypermedia texts' components, Survey Question 8 had students rate the usefulness of each of the elements of the multimedia reader – contextualized images, rollover translations, comprehension check exercises, cultural information, audio explanations – on a four point scale as (1) extremely useful, (2) somewhat useful, (3) a little useful, or (4) not at all useful. The background questionnaire solicited participant information about their major, year of study at the university, and perceived reading ability of difficult French texts.

Data analysis

An evaluation and assessment specialist from the university's division of instructional technology collected the surveys the day they were administered

Reading Format Preference Survey

The purpose of this survey is to gather information about your reactions and preferences to the two reading formats used in this course. The two reading formats were (1) Standard PDF text documents and (2) Multimedia readings.

Instructions:

For each statement presented you will be asked to rank the strength of your opinion on a sliding scale like the one below.

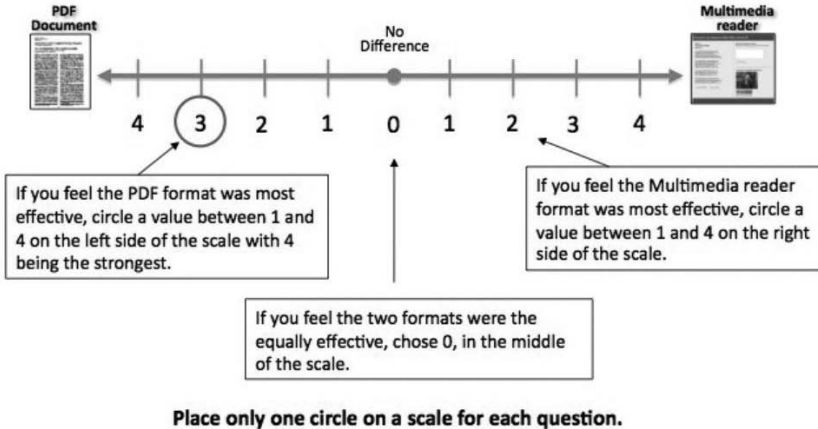


Figure 3: Example of the format preference sliding scale

and then conducted a one sample t -test with a p value less than 0.001 to find the significance of student format preference differences in survey questions #1–7. The first author also used descriptive statistics to report the percentage of participant responses to the format preference survey questions. Table 1 shows the survey results categorized by Research Questions 1 to 3, and notes significant differences found between formats for each survey question. For Research Question 4, the university specialist used descriptive statistic analysis to report student responses about the usefulness of each of the elements in the hypermedia texts from survey question #8. The relational usefulness of each annotation feature is reported by comparing the percentages of features reported as extremely or somewhat useful by learners on the survey.

Findings

Findings of this study are presented below according to four research questions, with descriptive statistical results and explanation.

RQ1. Which reading format do students prefer to learn the material?

Responding to the first research question, Table 1 shows that one sample *t*-tests found significant numbers of participants to prefer the hypermedia texts (69%) and to claim that the hypermedia texts motivated them to learn the material (77%) more than the print readings. Likewise, a group mean score of +1.74 ($SD = 4.15$) for Survey Q6 shows a learner preference for the hypermedia texts over print readings. A slightly more consistent, but lower group mean score of +1.69 ($SD = 3.64$) for Survey Q2 also shows learners' belief that the hypermedia texts motivated them to learn the material more than the print texts.

Table 1: Survey Responses to Research Questions 1 to 3

Survey Question Number	Print	Hypermedia	No Difference	**Mean	SD
RQ1 Format Preference					
Q2_Motivates	13%	*77%	10%	1.69	3.64
Q6_Format Preference	13%	*69%	18%	1.7	4.15
RQ2 Facilitates active learning					
Q1_Facilitates_Comprehension	6%	*90%	4%	2.43	2.39
Q3_Fosters_Reflection	20%	*70%	10%	1.51	4.43
Q4_Facilitates Critical Thinking	16%	*79%	5%	1.94	4.03
RQ3 Requires more effort					
Q5_Requires more mental effort	*73%	11%	16%	-1.39	3.86
Q7_Requires more time	46%	40%	14%	-0.14	6.82

* $p < 0.001$; **Mean (-4 to 0) = print preference; 0 = no preference; (0 to 4) = hypermedia preference

RQ2. Which format facilitates more active learning?

To respond to the second research question, Table 1 shows that one sample *t*-tests found significant numbers of participants to claim the hypermedia texts helped facilitate their comprehension of the texts (90%), to foster reflection on the content of the reading (70%), and to help them read difficult texts more critically (79%) than print texts. The group mean score of 2.43 ($SD = 2.39$) for Survey Q1 indicates a stronger, more consistent perception among students that the hypermedia texts benefited their understanding and comprehension of the reading materials. The group mean scores of 1.51 ($SD = 4.43$) for fostering reflection (Survey Q3) and 1.94 ($SD = 4.03$) for reading difficult tests more critically (Survey Q4) also indicate a perception of hypermedia text use as fostering active learning more than the print readings. However, a comparison of the standard deviations reveals stronger differences of opinion across formats for Survey Questions 3 and 4 than for Survey Question 1.

RQ3. Which reading format do students claim require more effort to understand?

To respond to the third research question, Table 1 shows that one sample *t*-tests found significant numbers of participants to claim that the print format required more mental effort to understand the content of the reading (73%) than the hypermedia texts. The group mean score of -1.39 ($SD = 3.86$) for format requiring more mental effort (Survey Q5) shows this belief to be relatively consistent across participants. On the contrary, participants were divided in their belief of which format required more time, and no statistical differences were detected across formats. Although the group mean score of -0.14 ($SD = 6.82$) for Survey Q7 indicates a slight belief that the print format requires more time, the standard deviation reveals strong inconsistency in this belief.

RQ4. The usefulness of each of the audiovisual features of the hypermedia texts

In response to the fourth research question, Figure 4 shows a continuum of student responses ranging from extremely useful to not useful at all. The following percentages of students reported that they found the specified features of the hypermedia texts extremely or somewhat useful in descending order: Rollover definitions (97%), audio explanations (83%), cultural information (80%), comprehension exercises (75%) and lastly, images (52%).

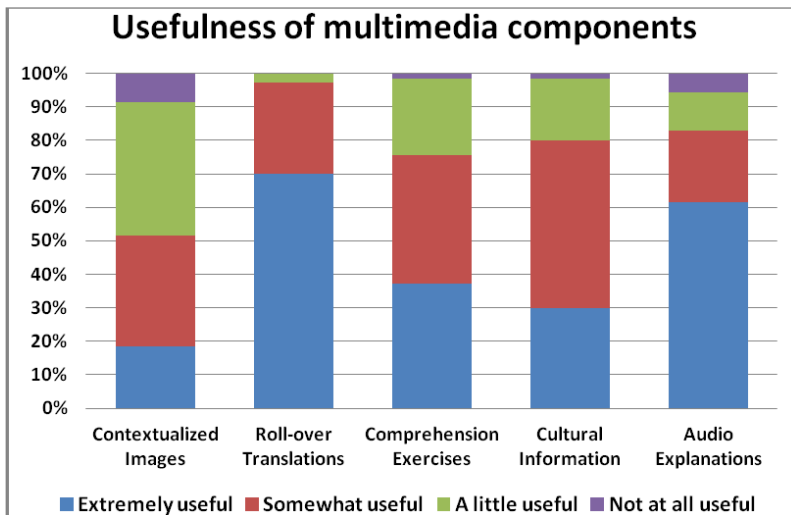


Figure 4: Student perceptions of the usefulness of hypermedia text affordances

To summarize the findings of Research Questions 1–4, it appeared that the multiple annotation features did not cause a cognitive overload for students, based on their positive claims about their use.

Discussion

Previous research findings on multimedia learning materials (AbuSeileek, 2008, 2011; Ariew and Erçetin, 2004; Sakar and Erçetin, 2005; Yanguas, 2009) have brought attention to the need to consider the limited capacity of learners' working memory when processing information in multimedia instructional design. Accordingly, this study investigated learner perceptions of the combined affordances in hypermedia text – (a) contextualized images, (b) rollover translations, (c) cultural information, (d) audio explanations, and (e) comprehension check exercises – compared to static traditional print readings with attention to the perceived mental effort claimed necessary to process the readings for each format. Findings from this study suggest that the use of multiple annotation features did not cause learners a cognitive overload based on the positive claims about hypermedia text use. In addition, no significant time expenditures were detected across formats.

A significant number of participants in this study not only preferred learning the material with hypermedia readings over traditional print versions (RQ1), but they also found the hypermedia texts more conducive to active learning by facilitating their comprehension of the texts and stimulating their reflection of the content (RQ2). It is interesting to note that the majority of the learners (97%) found the rollover translations useful, whereas only slightly more than half of the learners (52%) found the contextualized images useful. However, it is not surprising given that previous studies have found a strong learner preference for textual glosses over pictorial or contextual annotations due to the belief that accurate definitions are essential for comprehension (Erçetin, 2003; Ko, 2005). Moreover, as noted in the literature review, an extant threshold of lexical knowledge is necessary for readers to be able to allocate the additional attention resources needed to construct and integrate ideas from the context, draw information from long-term memory, monitor comprehension and to infer the meaning of new vocabulary from the context (Koda, 2005, 2007; Laufer, 1997; Pulido and Hambrick, 2008). Contrary to AbuSeileek's (2008) research-based suggestion to use the target language in glosses, limited to 3–5 words, the rollover translations in this study were in English, yet they were still considered useful by most participants.

The supplemental contextual annotations – cultural information and instructor audio explanations – were in the target language, but exceeded the ideal annotation word length (3–5 words) promoted by AbuSeileek (2008). The cultural information typically consisted of at least a paragraph and the instructor explanations lasted 30 seconds to a few minutes. It is surprising, and worth noting, that the supplemental contextual annotations were still considered useful by the students – audio explanations (83%) and cultural information (80%). Despite disruptions the supplemental contextual annotations

caused to reading the content of the hypermedia texts, a significant number of participants reported that more mental effort was required to read the print texts than the hypermedia texts. Mayer's (2005) cognitive theory of multimedia learning (CTML) offers a possible explanation for the perceived usefulness of supplemental contextual information in hypermedia texts. In the CTML information processing model, learners must first attend to and select relevant material. The instructor explanations in the audio files may have helped guide the learner in the selection process of relevant material. Next in the CTML model, learners organize the selected material into coherent verbal and pictorial representations and integrate these representations with prior knowledge. The supplemental cultural information may have helped fill voids learners held due to their lack of familiarity with L2 cultural contexts assumed to be common knowledge among target language speakers in their reading of the authentic text. The positive effect of cultural schema – background knowledge and cultural familiarity – on reading comprehension is widely accepted (e.g., Alptekin, 2006; Ketchum, 2006; Pulido, 2003). Yet, in this study the cultural information annotation was linked directly with the cultural reference in the text via a pop-up annotation that appeared on the right hand of a split screen while the text remained fixed on the left side of the screen. Several studies (AbuSeileek, 2008, 2011; Chen and Yen, 2013) have found pop-up annotations to be more advantageous than traditional glosses that split learners' attention from reading the text due to the physical separation, considering both the physical space and time required to retrieve the meaning. Providing learners cultural schema in a pop-up format may reduce the cognitive load imposed by a complex reading with unfamiliar cultural content given that a significant number of students perceived more mental effort required to comprehend the print texts.

The reading comprehension check activities implemented in this study were intended to provide immediate feedback to learners on the precision of the mental representations they formed during their reading. However, only 75% of students in the present study found the comprehension questions useful, ranking it fourth useful of the five annotation affordances. Students were required to send the correct responses to their instructor, via the CSCR hypermedia text software even though they were provided the correct answer after their second attempt. This requirement may have reduced student perceptions of the usefulness of this affordance, as none of the other hypermedia text features were mandatory.

Contextualized images were the least appreciated feature of the hypermedia texts, found useful by only 52% of learners. This is surprising given Mayer's (2001) claim that complementary audio (verbal mode) and visual (pictorial mode) input support reading comprehension more than just the

words. However, it is possible that the learners' lack of familiarity with the cultural references represented in the contextualized images, appearing immediately on the right side of the screen opposite the text for each new page, may have confused and distracted learners until they read the cultural annotations. Furthermore, the pop-up cultural annotations were linked directly with a referential section of the text whereas the contextualized images represented an entire page of the text, making them inherently more vague. None-the-less, this study corroborates previous research findings that students prefer textual explanations more than contextual guessing from images (Yanguas, 2009) due to the perceived lack of precision in interpreting pictures.

Despite the attention demands of the multiple audiovisual annotation features on learners working memory, a significant number of students perceived print texts to require more effort to understand than the hypermedia texts in this study. Contrary to previous research that found simultaneous audiovisual input to exceed learners' processing capacity for both visual and auditory input (Sakar and Erçetin, 2005), the combined use of audiovisual annotation features here did not appear to cause learners a cognitive overload. The learners' ability to select and attend to multiple audiovisual affordances individually, within their own time frame may be a crucial component to avoid splitting learners' attention from their reading comprehension with hypermedia texts. Furthermore, this study corroborates previous findings that easy to access annotations such as rollover translations and pop-up contextual information make L2 reading more manageable and enjoyable (Erçetin, 2003; Sakar and Erçetin, 2005).

Limitation and directions for future research

The findings in this study of learners' perceptions of hypermedia texts suggest the need for closer examination of this topic. If indeed hypermedia texts are as conducive to active learning as the participants in this study claimed, then additional resources should be invested in the design and use of this format. However, the generalizability of findings from this study is reduced by limitations in replicability inherent in the design of the texts – the selection of the contextualized images, individual instructor audio explanations and word translation choices – in addition to the unique student population. Firstly, the participants in this study may be considered high ability learners due to their self-selection of study into intermediate and advanced French language courses. Previous research has found significant differences in the ways in which high ability students interact with and learn from multimedia instructional materials compared to low ability students (Clark, 2001; Pulido and Hambrick, 2008). Secondly, it must also be noted that participants in this study primarily self-identified as French majors, and therefore may have had

more motivation and intrinsic interest in supplemental French cultural information and L2 reading comprehension mastery than learners who want to simply fulfill their foreign language requirements.

There are also possible limitations to the generalizability of the findings due to the novelty of hypermedia text use. As mentioned earlier, participants in this study were only exposed to a few hypermedia text readings per class. On a syllabus that had at least 30 reading assignments over the semester, predominately in traditional print format, there were only a few hypermedia readings. As long noted in the field of psychology, individuals commonly exhibit preferences for novel environmental stimuli, particularly if it is perceived as enhancing one's goals (Leventhal and Scherer, 1987). Additional research is needed to clarify if student format preference is due to the novelty of hypermedia text use. However, creating hypermedia texts requires extensive institutional resources – particularly faculty time and software support. Given the concern that the audiovisual features in the hypermedia texts could potentially split learners' attention from the content of a reading, it is of utmost importance to first gain an understanding of the perceived mental effort learners claimed necessary to process hypermedia texts compared to traditional print readings.

To conclude, it is well established that L2 reading fosters L2 literacy development (Kim and Krashen, 1997; Laufer and Sim, 1985; Nation, 2001; Pulido, 2007). Yet research on L2 reading motivation has found learners to lose interest in reading difficult L2 texts due to their lack of understanding of the content (Erçetin, 2010; Rodrigo, 2011). The hypermedia texts in this study contained audiovisual affordances intended to support L2 reading comprehension. However, warnings come from the field of instructional multimedia design to investigate emerging technologies, such as the CSCR authoring tool used to create the hypermedia texts in this study, to assure they address the needs of the human brain in learning (Mayer, 2005). The primary concern with the combined use of multiple audiovisual annotation features in the hypermedia texts under study was the brain's inherent information processing limitations of concurrent working memory (Sweller, 1988). However, findings from this study reveal users' belief that the hypermedia texts bolstered their active learning with less effort than traditional print readings. This finding supports the impetus to pursue future research to inform L2 instructors' design of hypermedia texts as authoring tools become more readily available.

Appendix A: Course Readings

Name	Genre	Format
<i>Course 1: French Language and Culture</i>		
Ecoliers	Poem	Paper
* Hanoi Cette Nuit	Poem	Electronic
Une Culture n'en Menace pas une autre	Narrative (interview)	Paper
* La Loi Toubon Censurée	Narrative (interview)	Electronic
<i>Course 2: Introduction to Literary Analysis</i>		
La Fonction de poète (Hugo)	poem	Paper
* Puisque le juste est dans l'abîme	Poem	Electronic
Un Coeur simple (extract 1) (*extract 2)	Short story	Paper electronic
Balzac et la Petite Tailleuse chinoise (extract 1) (*extract 2)	Novel?	Paper Electronic
Balzac et la Petite Tailleuse chinoise (*extract 1) (extract 2)		Electronic Paper
<i>Course 3 : Medieval Renaissance, and Early Modern Civilization</i>		
Extrait du Décret du Concile de Trente (extract 1) (*ex- tract 2)	Novel?	Paper Electronic
Le Traité des ordres et simple dignité (*extract 1) (extract 2)	Novel?	Electronic Paper
*Mémoires (extract 1) (*extract 2)	Novel ?	Paper Electronic
<i>Course 4: Modernity</i>		
Duellum (Baudelaire)	Poem	Paper
*Correspondances (Baudelaire)	Poem	Electronic
Parfum Exotique (Baudelaire)	Poem	Paper
*Harmonie du soire (Baudelaire)	Poem	Electronic
Spleen (Baudelaire)	Poem	Paper
*L'Albatros (Baudelaire)	Poem	Electronic

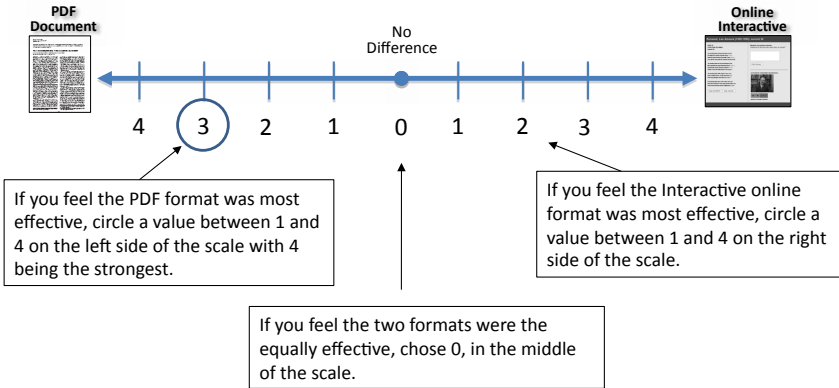
Appendix B

Reading Format Preference Survey

The purpose of this survey is to gather information about your reactions and preferences to the two reading formats used in this course. The two reading formats were (1) Standard PDF text documents and (2) Online Interactive readings.

Instructions:

For each statement presented you will be asked to rank the strength of your opinion on a sliding scale like the one below.



Place only one circle on a scale for each question.

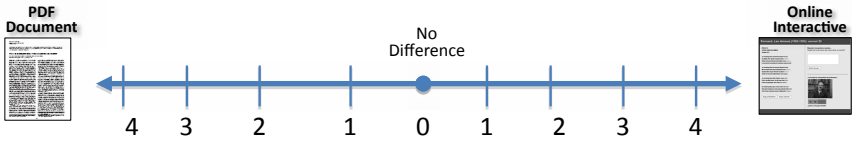
Question 1:

Which reading format enabled you to better understand and comprehend the content of the reading? (1= a little more effective, 4=much more effective)



Question 2:

Which reading format motivated you the most to learn the material? (1= a little more effective, 4=much more effective)



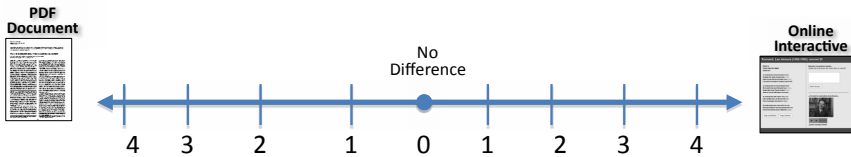
Question 3:

Which reading format did you reflect on the content of the reading the most? (1= a little more effective, 4=much more effective)



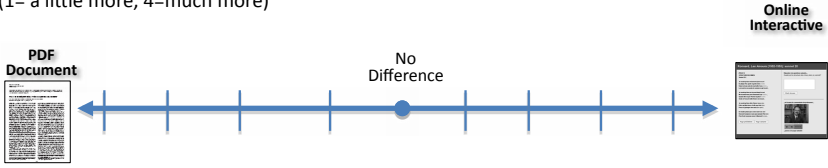
Question 4:

Which reading format helped you to read difficult text more critically? (1= a little more effective, 4=much more effective)



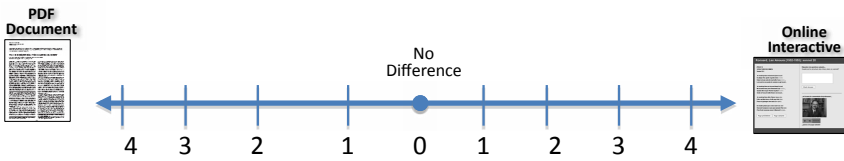
Question 5

Which reading format required more mental effort to understand the content of the reading? (1= a little more, 4=much more)



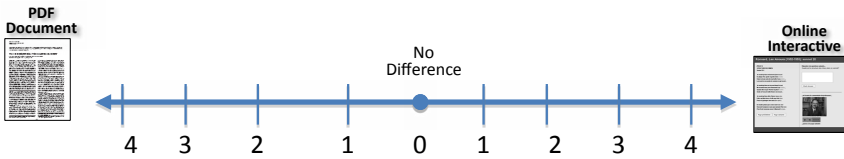
Question 6

Which reading format did you prefer the most? (1= a little more, 4=much more)



Question 7

Which reading format did you spend the most time reading the text? (1=a little more time, 4=much more time)



Question 7:

Please rate the usefulness of each of the following elements of the multimedia reader:

	Extremely Useful	Somewhat useful	A little useful	Not at all useful	Not Applicable
Images					
Roll-over definitions					
Quizzes					
Cultural information					

Please provide your unique identifier:

- Day of the month you were born (e.g. 01-31):
- First two letters of the high school from which you graduated:
- Last two digits of your social security number:

Estimate what percentage of the readings you did for this course:

0% 25% 50% 100%

Year of college: sophomore junior senior grad

Your major: _____

Prior experience reading historical texts: none a little a lot

Grade you expect to receive in this course: _____

Additional comments:

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