

Flexible Coherence: Re-Thinking e-Learning Design Principles for Linguistically and Culturally Diverse Students

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Abstract

This article presents the results from a post-test only experiment conducted in 2011 with undergraduate and graduate students (N=67) from individualist and collectivist cultures. Demographic information was collected through questions appearing at the end of a post-test administered to subjects after completing the e-learning module. Each person was randomly assigned to one of three e-learning modules which all shared identical instructional content: time travel. However, the modules differed in design. Specifically, while the control module was designed according to the coherence principle, one experimental module was designed with non-essential background music and the other was designed with non-essential background images. The coherence principle of multimedia instruction stipulates that the addition of extraneous audio, images, or text impairs learning. Nevertheless, one normative standard of multimedia design does not apply to a group of culturally and linguistically diverse learners. Among the findings from this study, a *flexible coherence principle* is proposed and it suggests that the multimedia designer must consider one's own cultural and linguistic composition as well as that of the intended audience. A concluding discussion suggests that cultural variation may be related to cognitive variation.

Keywords: *E-learning; Linguistic relativism; Cognitive Load Theory; Coherence principle; Collectivist - Individualist; Multimedia design*

Introduction

Language is the medium by which individuals acquire knowledge. By knowledge this means the collection of information, skills, beliefs, and awareness gained through exposure to experience, facts, observation, and situations. Effectiveness of instructional content depends on the nature of its design given that human beings acquire knowledge through language. Poorly designed instructional materials make reaching the stated objectives difficult or impossible. However, it is likely that achievement of learning objectives may depend on the language of the learner. Further, the design of instructional content should be adapted to different learner cultural backgrounds. It was the purpose of this study to find answers for both of these suppositions.

Review of Literature

Coherence Principle

Clark and Mayer (2010) propose a cognitive theory of multimedia learning that defines learning as an active process of *sense-making*. It defines teaching as an attempt to encourage adequate cognitive processing in the learner. Research is therefore needed to determine the effect of the interaction of cultural dimensions and the coherence principle on achievement.

The cognitive theory includes several multimedia principles that serve as guidelines for instructional designers of multimedia with an educational objective (Clark & Mayer, 2010). Tested in laboratory experiments (Mayer, 2001; Harp & Mayer, 1998; Sanchez & Wiley, 2006), the coherence principle asserts that the addition of extraneous information can hurt or impede learning. Non-essential or extraneous information includes (1) entertaining stories related but not essential to the instructional objective, (2) background music and environmental sounds added for motivation, and (3) images or detailed textual descriptions. According to Clark and Mayer (2010), these extras may harm learning through distraction, disruption, and seduction. Numerous studies support the multimedia elements principles as outlined in Clark and Mayer (2010), several of these studies include: Harp and Maslich (2005), Harp and Mayer (1998); Mayer, (1998); Mayer, (2001); Moreno and Mayer, (2000); Mayer and Anderson, (1991); Mayer, Heiser, and Lonn, (2001); Renninger, Hidi, and Krapp, (1992); Robinson, (2002).

The coherence principle is one of many such principles that are prescriptions as to the design of instructional content per the cognitive theory of multimedia learning. It is based on three assumptions, (1) dual channels, (2) limited capacity, and (3) active processing.

Dual Channels

Human beings possess within their cognitive structure separate processing channels for visual and verbal information. This is the core of the dual channels assumption. It is rooted in research and perspectives articulated by Mayer and Moreno (2003) drawing on Paivio's (1986) dual-coding theory and Baddeley's (1992; 1998; 2000) theory of working memory. This theory states that working memory is limited to approximately seven items of information that an individual can remember at a given point. Mayer (2001) proposed that efficient learning and instruction is accompanied by taking into consideration the separateness of the verbal and nonverbal channels. Mayer modified the term *visual* to *nonverbal* to allow for sound and motion. For Mayer, there is a presentation-mode approach implied in Paivio's contribution that distinguishes between verbal and nonverbal learning. Thus, pictures or music are processed by one channel, whereas verbal words and sounds (spoken language) are processed by a separate channel.

Limited Capacity

A limited amount of processing capacity exists in visual and verbal channels. This is rooted in the work of Miller (1956), Baddeley (1992), as well as Chandler and Sweller's (1991; Sweller, 1994)

cognitive load theory. The theory posits that a person is able to remember a limited amount of presented material, and while this amount may vary from person to person (Mayer, 2001), it is still *limited*. Types of cognitive load include intrinsic and extrinsic. Difficult subject matter (in terms of the amount of instructional items presented and the interconnectedness between items) refers to intrinsic load. Design and delivery of instructional content refer to extrinsic load.

Active Processing

The act of learning requires substantial cognitive processing in the verbal and visual channels. The active processing assumption implies that we tend to pay attention to and select from presented instructional content, organize it, and integrate it into a coherent cognitive structure that is connected to older knowledge (Mayer, 2001). Central to Wittrock's (1989) generative-learning theory is the assumption that learning is neurological meaning-making as contrasted with memorization. Generative learning relates to the cognitive processes involved with crafting relationships between concepts and experience. Wittrock's (1992) research tracks cognitive processing and retention of information at the relational level. Mayer (2001) adds to this the *selection-organization-integration* theory of active learning (Mayer & Moreno, 2003).

Critique of Cognitive Theory of Multimedia Instruction (and Coherence Principle)

The problem with the logic of the cognitive theory of multimedia learning is the implicit assumption that language does not have any influence on thought (Wiggins, 2011). In particular, there is no discussion as to whether a language could influence the way in which associations are made within the individual about verbal and nonverbal information. There is no disagreement here as to whether processing verbal and related nonverbal elements in an instructional context proceeds along separate channels. It is unlikely, however, that each person would associate a given image, object, or sound to a given word or concept similarly and uniformly. It is likely that language and culture impact expressed and internalized meaning differently depending on the particular case. Specifically, Paivio's (1986) distinction seems to imply the same categorical dichotomy as Saussure's (1983) *langue* and *parole*. The former is the abstract system of language and the latter implies concrete speech utterances. Clark and Mayer (2010) and Mayer (2001) assume through an interpretation of Paivio's dual-coding theory that during instruction, narration (verbal information) may initially proceed along the verbal channel, but may also be processed as if it were nonverbal information, in the same way that words can conjure up images. However, if language influences thought, then generalizations should not be made as to the presumed impact that verbal and nonverbal cues may have on linguistically and culturally diverse learners.

Universal Grammar and Linguistic Relativity

The cognitive process of the brain contains structures that exist as a means for the assemblage of grammatical items. Language is the medium through which the principles and guidelines of grammar realize thought. However, grammar is enacted through the existence of a structure or

faculty that enables the acquisition of language, formation of grammatical rules and order, and the development of knowledge. This structure makes linguistic acquisition and expression possible.

Universal Grammar

Universal Grammar (UG) is a trait of the human organism's faculty to acquire language (Chomsky, 1965; 1986, p.5). Generative grammar emphasizes the role of knowledge that is to be acquired through use of language (1965). Traditional and structuralist approaches to explaining grammar deal more with elements of a given language and not with knowledge that can be attained once those elements have been acquired.

In recalling von Humboldt's (1836) contribution in *Über die Verschiedenheit des Menschlichen Sprachbaues* [On the Diversity of Human Linguistic Structure] Chomsky acknowledges (1987, p.152) that while the laws of a language may be fixed, the generative principles are unfettered by the free creation of the individual. For Chomsky the generative aspect is genetic. Indeed, von Humboldt's term *erzeugen* (to create) implies the *creation* of a thing from materials dissimilar to the product. What we refer to as *language* is the generative ability of the cognitive structure to create new combinations of linguistic elements that become distinct units of larger systems of communication and meaning-making. Implied is the notion that the human brain is inhabited by a pre-coded or preprogrammed faculty that epigenetically works to acquire language. This metaphor of the mind as a computer is common to Cognitivism.

Regardless of the actual source of language and thought and how human beings articulate these in reality, the sphere of origination of language in the brain *may* contain within it a preprogrammed structure. Irrefutable are the distinctive products of thought among the varied cultures and languages in our world. These products are the verbal and non-verbal forms of expression that emanate from the brain. Chomsky (1965; 1986; 1987) argues that UG explains the constitutive aspect of the initial state as being common to all people, yet the outcome of this initial state is perceived in terms of different grammars and languages which ultimately determine meaning in similar or dissimilar ways. In other words, what starts as common to all emerges as being unique to those who share the same internalized language or grammar.

Linguistic Determinism and Relativism

Extreme versions of linguistic determinism posit that all aspects of language influence or shape all aspects of thought. This implies that unique differences exist between peoples and cultures, and that one's perception of the world is shaped by the language(s) one speaks. Less extreme versions (like those associated with linguistic relativism) simply suggest that languages differ in significant ways (Pederson, 2007).

The Sapir-Whorf hypothesis, which is often considered a starting point for discussions of linguistic relativism, suggests that individuals make sense of reality through the medium of language. Specifically, this notion places the role of perception and comprehension of reality in the language spoken by a particular person regardless of the time or place (Carroll, 1956).

Lakoff (1996), Gumperz and Levinson (1996), Slobin (1996), and more recently Boroditsky (2001; 2011) have re-examined linguistic relativism. Lakoff proposed four parameters that discuss criticisms and issues with regard to the Sapir-Whorf hypothesis. Each parameter presents a difference in opinion reflecting prior research; for example, the fourth parameter asks whether to view the locus of linguistic relativism as being in the language or in the mind. However, Pinker (1994) insists that the Sapir-Whorf hypothesis, as well as linguistic relativism, is not to be taken seriously. Pinker asserts a meta-language (or *mentalese*) as that linguistic medium whereby humans conduct their thinking. He insists that we do not think in natural language, i.e. as in that language we use to communicate with others in text, talk, video, audio, song, etc.

Support of Linguistic Relativism

Tohidian (2009) reviews a history of work done on linguistic relativity to conclude that language indeed influences thought and one's world view, but that these are not governed by language. This is a unique and important distinction that harkens back to the difference between extreme and less extreme versions of the hypothesis. An earlier study by Hoffman, Lau, and Johnson (1986) found that language in bilingual English-Chinese speakers appeared to have some impact on the use of stereotypes. Lucy and Gaskins (2001) found evidence to support the thesis that certain grammatical aspects may shape the way English and Yucatec Mayan speakers conceptualize shapes and substances of objects. Reines and Prinz (2009) provide further partial support of the linguistic relativity hypothesis. Hunt and Agnoli (1991) argued that for some languages, certain thoughts are more parsimonious or economical than their verbal counterparts in another language. This suggests that while language may not directly impact or determine thought, it is potentially easier or more difficult to conceptualize something in one language as opposed to another. The German word *Schadenfreude* is an appropriate example. In one word, it means (in English) 'taking joy in another's pain or suffering'. It is more economical to use the German phrase than the less economical English version.

Critical Discussion

Assuming that language shapes thought, even if only partially, it is possible that what is processed in working memory during instruction may differ in terms of associative meaning and schematic construction depending on culture and language. Mayer (2001) assigns working memory the role ascribed to it by Baddeley (1992) and others, namely, that its primary function is to process actively consumed input, potentially both verbal and nonverbal, along separate channels. One channel deals with sounds and verbal or spoken information, and the other channel handles nonverbal and image or pictorial representations (Mayer, 2001, p. 45). Mayer extends this assumption to suggest that the verbal or spoken word may prime the nonverbal pictorial representation.

He implies that when one hears the word cat one necessarily visualizes a cat. However, one person's interpretation of the sound (signifier) may differ from another person's conceptualization (signified) especially upon consideration of linguistic and cultural diversity (Saussure, 1983). As an applied example, Boroditsky (2001) found that speakers of German assign notions of rigidity or

vigor to the masculine-gendered word key [German: der Schlüssel] as contrasted by French speakers assigning elegance and finesse to the feminine-gendered word key [French: la clé]. Thus, while visual and auditory items are processed along separate channels, it should not be assumed that each person associates the mental representation of an idea or thing with the verbal or spoken word used to signify the concept. Therefore, and by extension, it is conceivable that adhering to one approach in e-learning design, namely the coherence principle, may not apply to the diversity of learning styles available given the cultural and linguistic differences that exist. It is with this primary rationale that a link is established between the previous literature and the study conducted by the researcher. This link justifies this and future studies.

Methods and Procedures

In order to maintain parity with prior studies in this field, the researcher used an experimental design (Harp & Mayer, 1997; Mayer & Anderson, 1991; Moreno & Mayer, 2000; Renninger, Hidi, & Krapp, 1992). This study sought to contribute new knowledge to the discipline of communications within the larger field of the social sciences by examining the impact of cultural dimensions and the coherence principle on the achievement of educational objectives in an e-learning environment. The following provides a critical discussion of each aspect of the research design.

Sample and Demographics

This study used a sample of 67 undergraduate and graduate students enrolled in courses at a major university in the Pennsylvania State Systems of Higher Education (PASSHE) during spring 2011. Overall there were 36 undergraduate or graduate students from collectivist cultures and 31 students from an individualist culture. Cultural information came from questions appearing at the *end* of the post-test to avoid priming cultural biases in the subjects. Here, the term *collectivist* is not a political concept but represents a dimension of national or real cultures and pertains to those societies which emphasize harmony, group interests, and “cohesive-in-groups [that] continue to protect [individuals] in exchange for unquestioning loyalty” (Hofstede & Hofstede, 2005). It is a concept forming a part of the individualist collectivist (I/C) construct (Triandis, 1995). Individualism is the conceptual opposite of collectivism and implies societies that have loose ties between individuals in the sense that the individual is expected to see to oneself or to one’s immediate family.

Questions appearing at the end of the post-test asked for the following demographic information from each of the subjects in the sample: gender, age, native language, country of origin, degree sought at the time of the study, grade point average (GPA), program of study, and online course experience.

Grade point average is indicative of the same pattern. Frequencies show that among the collectivists for all modules, the majority of subjects (83%) had a GPA of 3.5 or higher, including 47% with a 4.0. By contrast the frequencies among the individualists indicate that 55% had a GPA that fell between 2.0 and 3.49; only 29% had a 3.5 – 3.9 and 16% had a perfect 4.0 grade point average.

The disparity in GPA scores between the two cultural dimensions suggests that students enrolled in graduate-level courses in the sample had higher grade point averages than undergraduate students. This may be due to the higher percentage of graduate students in the collectivist sample than in the individualist sample.

Native Language and Country of Origin

Native language varied more in the collectivist group than in the individualist group. All 31 of the individualist students listed English the native language and the United States as country of origin. English was the native language for 47.8% of the overall sample. The second most common native language in the overall sample was Mandarin Chinese (38.8%). In the collectivist group Chinese (either Mandarin or Taiwanese) comprised 75% of the native languages among participants.

Each subject listing Mandarin Chinese as the native language noted the People's Republic of China as the country of origin. Numbering only one subject per language, collectivist subjects noted the following native languages (country of origin is in parentheses): Saudi Arabic (Saudi Arabia), Hindi (India), Japanese (Japan), Korean, Punjabi (India), Spanish (Peru), Taiwanese (Taiwan), Thai (Thailand), and Vietnamese (Vietnam).

Experimental Design

Following the previous discussion about the absence of language and culture in e-learning design principles (Wiggins, 2011), this study explored whether using Clark and Mayer's coherence principle applies to linguistically and culturally diverse students. The researcher developed three e-learning modules, each with identical content. Each module differed *only* in design. One was designed according to the coherence principle. Two others broke this rule as one had non-essential background audio, the other background images. The content was time travel as that allowed for certainty that subjects participating in the experiment had little or no prior knowledge of the instructional content. The learning objectives: articulate the basic laws on time travel and identify the correct symbol sequences on the time travel console (both of which were created by the researcher). A post-test measured retained knowledge. The researcher randomly assigned one of the three modules to the subjects, separately. There was no way to predict which person would take the control or either experimental modules.

Instructional Content of Module

The content of the instructional module, as discussed above, is time travel. Specifically, the module instructed each learner how to use a time travel device. As mentioned previously, the time travel narrative was appropriate given that subjects would not likely have any prior knowledge as to the specific mechanics and temporal laws behind the time travel device as depicted in the module. The purpose of the module from an instructional point of view was to educate the subject as to how to use the time travel device and to become familiar with its associative temporal laws.

The module began with a brief introduction as to the nature of the device. Following this was a cursory lesson on laws associated with time travel. It is important to note that while the content of the module is mostly fictional, the laws are rooted in a mixture of science fact, conjecture, and science fiction.

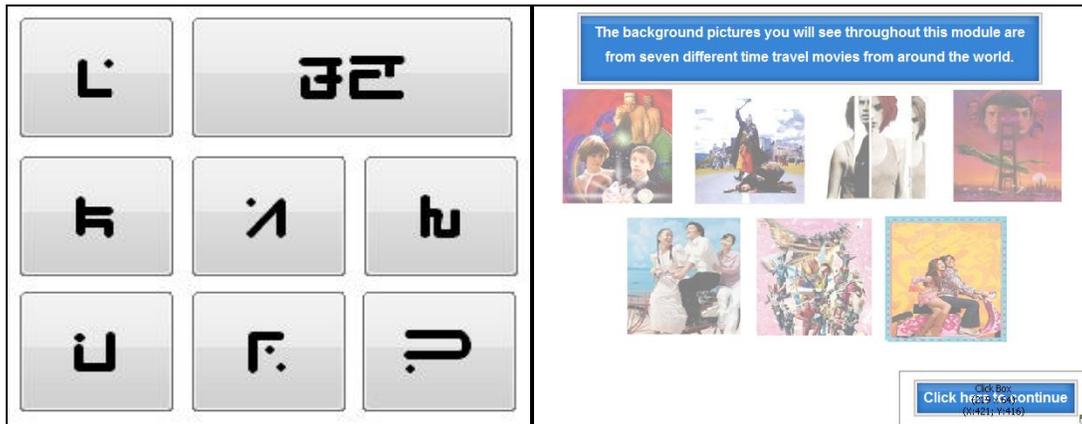


Figure 1. (Left) A close-up of the time travel console used in all of the modules and (Right) an introduction slide in the experimental module with images. The image was in the background of all slides in that experimental module.

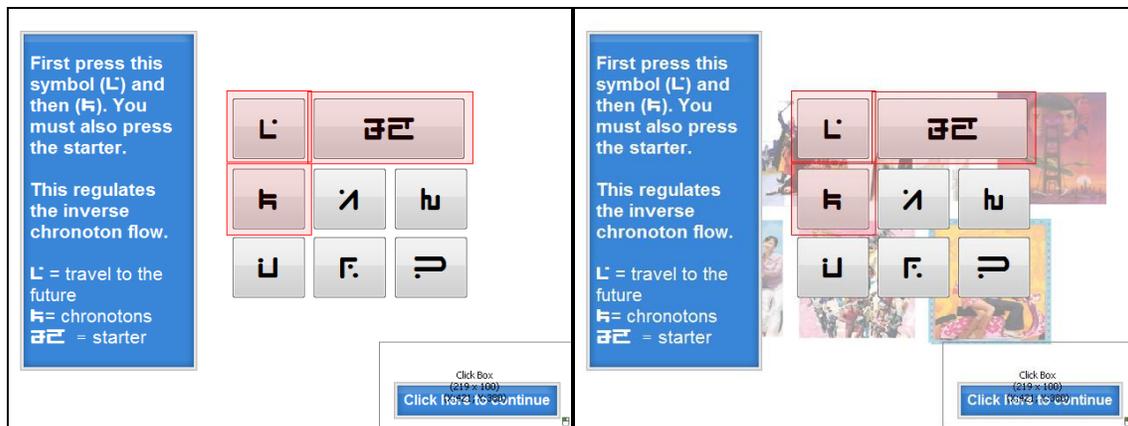


Figure 2. (Left) Screenshot of the control module and (Right) Screenshot of the experimental module with non-essential background images. The experimental module with non-essential background music looks identical to the control module with the only exception being the background music.

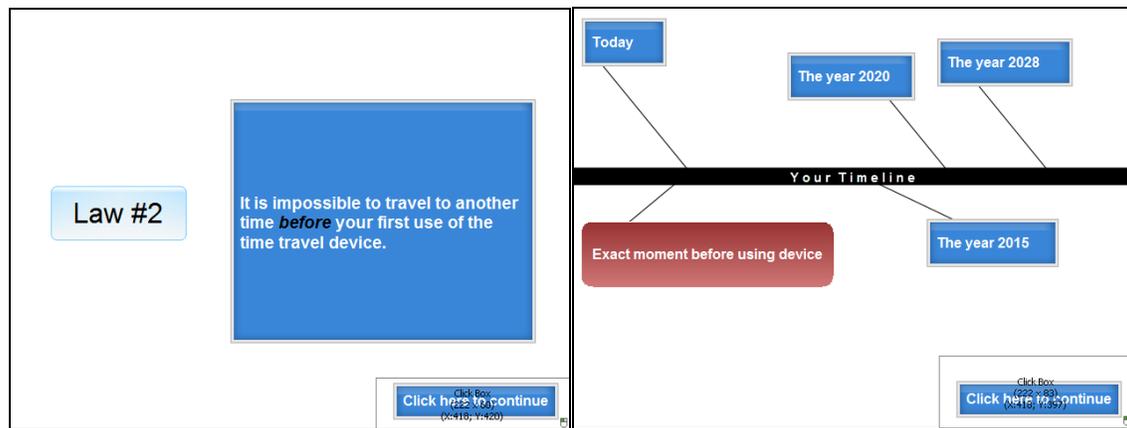


Figure 3. (Left) The second of the three time travel laws and (Right) its explanation as depicted in the control module and experimental module with non-essential background music.

Non-essential Audio and Images in Experimental Modules

Non-essential music and images were added to the modules thus making them contrary to the coherence principle were. According to Clark and Mayer (2010, p.118), adding background music does not improve, and is likely to impede, learning. This study incorporated the unobtrusive musical piece, *Song to the East* by Hungarian guitarist Ferenc Snetberger (2001), with no lyrics and only one instrument. Clark and Mayer also argue that extraneous images should be excluded from instructional content. Accordingly, non-essential images were included in the second experimental version. This is explained further in subsequent paragraphs.

Using non-essential images in an instructional module is strongly advised against by Clark and Mayer (2010). Studies have used both computer and paper-based instruction to test whether the coherence principle is tenable (Harp & Mayer, 1997; Mayer, Heiser, & Lonn, 2001). These studies posit that the addition of images to enhance the content of an instructional lesson, computer or paper-based, will prevent students from being able to learn deeply. Accordingly, this study incorporated seven extraneous images of time travel movie posters. Three of the seven images came from countries identified as individualist and four were from collectivist countries. These countries are defined as collectivist or individualist per Hofstede (1980; 2001), Hofstede and Hofstede (2005), and Triandis (1995). The three individualist countries are: France, Germany, and the United States. The four collectivist countries are: India, Japan, Russia, and South Korea.

Findings

First Hypothesis

H1: Individualist subjects will achieve a similar score as compared to collectivist subjects on the control module. The first hypothesis suggests that the scores will be similar between the two

groups. Further, the argument is that there will be no significant difference between the two control groups.

An independent samples t test found no significant difference between the control groups on either the symbol sequences section ($t(15) = .943, p = .36$) or the overall post-test ($t(20) = 1.693, p = .10$). However, a statistically significant difference was detected between the control groups on the time travel laws section ($t(11) = 2.345, p = .039$).

Second Hypothesis

H2: Individualist subjects will achieve a similar score on the experimental module with audio adjuncts as compared to collectivist subjects. An independent samples t test compared the means in both experimental groups that received the module with extraneous audio. No significant difference was detected between the groups on the overall post-test ($t(10.46) = 2.06, p = .065$). The research hypothesis is supported. The section on time travel laws ($t(9) = 2.236, p = .052$) indicates no statistically significant difference, but the proximity to showing a difference is evidenced by the p value of .052, thus suggesting caution.

Third Hypothesis

H3: Individualist subjects will achieve a similar score on the experimental module with image adjuncts as compared to collectivist subjects. An independent samples t test was computed to detect any differences between the IND and COLL experimental groups with images. A statistically significant difference was found ($t(13) = 2.474, p = .028$) on the overall post-test. The third research hypothesis is not supported. However, no differences of statistical significance were detected in either of the two sections upon separate analysis.

Fourth Hypothesis

H4: Individualist subjects in the control group will score differently than individualist subjects in either experimental group. Separate t test results showed no statistically significant differences between the IND control and either of its two experimental groups. These results (in Tables 1 and 2) do not support the fourth research hypothesis. Differences were expected given the research on the coherence principle. Since the two experimental modules included audio and images, respectively, it was hypothesized that the control group scores would be higher than both of the experimental groups. In fact, the individualist group receiving the module with non-essential images achieved the highest post-test scores overall. These findings stand in stark contrast to prior research on the coherence principle. No t test statistic (*) could be computed for the time travel laws section since each IND group scored perfectly on the time travel laws section. In the interest of exploring any differences or similarities between the collectivist control and experimental groups, the researcher calculated t-tests between the collectivist control and each of its experimental groups. No statistically significant differences were found.

There has been no previous investigation of the coherence principle and culturally and linguistically diverse students audiences. These results indicate that for the collectivists in this study, subjects performed similarly and achieved moderate to high scores in the control and two experimental versions. In other words, the potential distractions presented by the non-essential audio and images did not lead to lower post-test scores compared to the control group for those subjects in the collectivist cultural dimension.

Table 1. Independent Samples t-test for IND Control Group and IND Experimental Group with Music

Post-test (Control * Exp/Music)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Symbols	.000	18	1.000	.00000	.18856
Time Travel Laws	*	*	*	*	*
Overall Scores	.000	18	1.000	.00000	.18856

Table 2. Independent Samples t-test for IND Control Group and IND Experimental Group with Images

Post-test (Control * Exp/Images)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Symbols	-1.577	19	.131	-.20000	.12679
Time Travel Laws	*	*	*	*	*
Overall Scores	-1.577	19	.131	-.20000	.12679

Interaction Effects (Cultural Dimension * Coherence Principle)

The researcher computed a two-way analysis of variance to examine the interaction between the independent variables in this study, namely, cultural dimension and the coherence principle (module design). Each independent variable is categorical. The cultural dimension variable is comprised of the collectivists and individualist categories. The coherence principle variable is comprised of the three module types (control and two experimental).

No interaction effect ($F(2) = .113, p = .893$) was found. Viewing the coherence principle as a main effect ($F(2) = .304, p = .739$), the results in Table 3 indicate that learning about the content from one of the three modules did not influence achievement on the post-test. Culture as a main effect ($F(1) = 11.399, p = .001$) indicates that the cultural background (or perhaps the native language of the subject) influenced achievement on the post-test. The $R^2 (.167)$ shows that (16.7%) of the total variability in post-test scores can be explained by culture and the coherence principle. This percentage leaves much of the observed variability unexplained, although culture and the coherence principle are not significantly related to achievement on the post-test.

Table 3. Tests of Between-Subjects Effects with the Total Score on the Post-test as the Dependent Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta ²
Corrected Model	11.099 ^a	5	2.220	2.441	.044	.167
Intercept	8739.599	1	8739.599	9611.215	.000	.994
CP ^b	.553	2	.276	.304	.739	.010
Culture ^c	10.365	1	10.365	11.399	.001	.157
CP * Culture	.206	2	.103	.113	.893	.004
Error	55.468	61	.909			
Total	8847.000	67				
Corrected Total	66.567	66				
a. R ² = .167 (Adjusted R Squared = .098) b. CP = Coherence Principle c. Culture = Cultural Dimensions						

Results

This study contributes new knowledge in the areas of cognitive theory of learning, cognitive linguistics, e-learning, and communications. No previous studies examined whether designing an e-learning module according to the coherence principle interacts with the cultural or linguistic diversity of the learner.

In order to operate the time travel device correctly and safely, it was not enough to enter the symbol sequences in the correct order. Subjects also had to learn about the three time travel laws. The difference in scores on the time travel section may be due to the dissimilar ways human beings perceive and articulate time as an abstract concept. Not all people understand time in homogeneous ways. The uniformity in Universal Grammar (UG) presupposes that since one human language conceptualizes time, another will likely allow for some concept for time. The diversity in applying the concept of time is due to differences in the ways speakers of some languages perceive time compared to speakers of other languages. Contrasting with this explanation is the notion that a different cognitive reasoning process may have been necessary to learn the time travel laws. The time travel laws section may have required more of the subjects than the symbol sequences section in terms of abstraction, language level, reasoning, etc. However, that argument does not explain why individualists scored well in that section in all three module types, except that all individualists were native speakers of English.

First Hypothesis

The first hypothesis posited that individualist subjects would achieve a similar score as compared to collectivist subjects on the control module. The second image included in Figure 1 (shown earlier) illustrates the timeline used for explaining more about the time travel laws. What each slide contains is a linear representation of time with an implicit understanding of “back” or “before” to mean the past and “ahead”, “front”, or “then” to signify the future.

Time Expressed as a Linear Concept

Ten of the twelve collectivists (83%) in the control group were native speakers of Chinese. The lower post-test scores on the time travel laws section is likely explained by the difference in how Chinese speakers perceive time. The time travel laws were instructed using a Western or individualist orientation toward time with a linear, horizontal left-right timeline. Events on the left side were understood as the past; those on the right are generally the future, relative to the point indicated as the present. The collectivist group scored lower on the time travel law section because the instruction was geared for an individualist orientation toward time, even though the subject matter was entirely fictional. In experiments seeking to understand whether language shapes thought, Boroditsky (2001) found that speakers of Mandarin Chinese perceive time in horizontal *as well as* vertical ways. By contrast, English native speakers conceptualize time in strictly horizontal ways. Also, a tendency for long-term planning exists among Chinese people, and the orientation toward time in Confucian cultures suggests a flexible attitude and one that is multidimensional (Hofstede & Hofstede, 2005; Nisbett, 2003; Li, 2008).

Incidentally, in the collectivist control group, 83% of the participants were native speakers of Chinese with the remaining two subjects (17%) being native speakers of Punjabi and Hindi, respectively. Neither of the two non-Chinese people made any errors on the time travel laws section. However, 60% of the Chinese speakers made errors on the section.

Second Hypothesis

The second hypothesis proposed no differences would be detected between the experimental groups receiving the module with background music. The second research hypothesis is supported for a critical reason. Research on the coherence principle of multimedia learning informs us that the addition of non-essential music (or other audio adjuncts) hurts learning. The independent samples t test revealed no significant difference on the overall score of the post-test. Yet literature and prior research have indicated that adding extraneous music is detrimental to learning; thus, there should be a difference. Why was there no significant difference between the groups? Further, why did both groups score highly relative to each other on the overall post-test (IND: $M = 11.8$; COLL: $M = 10.8$)? The answer may lie in the inherent interest level in the instructional content of the e-learning module.

Interest Level in Instructional Content

Many of the subjects remarked at how much they enjoyed the module, how interested they were in learning the symbol sequences, and about the general topic of time travel. I received such comments from both collectivists and individualists. In fact, one subject in particular sent a follow-up email indicating a willingness to participate in future experiments since this one was so enjoyable (personal communication, February 20, 2011).

If the level of attention in the instructional content was high, subjects may have been aroused by the content of the e-learning module. The level of interest may have neutralized the non-essential

music distraction. Interest in subject matter may also explain the high level of subject performance in the symbol sequences section.

Garner, Gillingham, and White (1989) and Sanchez and Wiley (2006) speculated about the inclusion of seductive details to enhance the interest in the instructional content. Formulated as arousal theory, this conceptual approach advocates the *inclusion* of entertaining text, images, or auditory adjuncts to amplify the interest level so that learning is improved. The important difference between the assumptions behind arousal theory and my interpretation of these results is that the subject matter of the module may have compensated for the potentially harmful effect of the audio adjuncts. As the time travel subject matter was perhaps sufficiently interesting for the participants, the addition of non-essential information did not hurt learning in either group. It's important to note that the music had no connection to the module's subject matter.

Third Hypothesis

The third research hypothesis posited no significant difference between the two experimental groups receiving the module with image adjuncts. Interestingly, the difference between individualist and collectivist group scores was found to be statistically significant on the overall post-test, as well as on the two sections when analyzed separately. Unique to this module was score variability among collectivist subjects; there was no variability in the individualist scores.

Consistency in Presentation of Non-essential Images

The significant difference in post-test scores may also be explained by the manner of presentation of the image adjuncts. Individualist subjects may have perceived the image adjuncts as *part* of the experience. The consistency of the images helped the module to appear as a single unit to the individualists.

In contrast, collectivist subjects (79% of which were Chinese native speakers) achieved lower post-test scores probably due to the incongruity in the manner by which the module presented instructional content. The individualist subjects were unaffected by the inclusion of the image adjuncts. The images likely distracted the collectivist subjects on both sections to result in a statistically significant difference when compared to individualist post-test scores. Given the difference in scores on the symbol sequence section of the post-test, it is likely that the addition of images served as a greater distraction than music. Considering the results from testing the second hypothesis, the audio adjuncts did not distract either group of subjects. The images distracted collectivist subjects enough to perform poorly on both sections thus leading to a significant difference between cultural groups.

Fourth Hypothesis

The fourth hypothesis served to test the tenability of the coherence principle. Differences were expected in individualists' post-test scores between the control and both experimental groups.

Past research on the cognitive theory of learning has not discussed cultural or linguistic diversity of subjects used in such studies. There was therefore no basis to hypothesize such similarities or differences between the control and experimental groups for the collectivist subjects. Results indicate no significant difference between the control and both experimental groups for individualist subjects. According to the findings from numerous studies (Harp & Maslich, 2005; Harp & Mayer, 1998; Mayer, 1998; Mayer, 2001; Moreno & Mayer, 2000; Mayer & Anderson, 1991; Mayer, Heiser, & Lonn, 2001; Renninger, Hidi, & Krapp, 1992; Robinson, 2002) evidence suggests that the addition of extraneous audio or images hurts learning. The findings from this investigation are in stark contrast to the previous research. The control and both experimental groups achieved similarly high scores on both sections of the post-test.

Explanation of Uniformity of Post-test Scores

It is likely that consistency and interest-level were both factors that led to similarly high post-test scores among individualists, and perhaps also among collectivists. This is not to suggest that multimedia designers should add audio to their instructional modules without consideration of the potential for negative impact on learning. Rather, these results merely indicate that given the individualist subjects collected for the study non-essential audio adjuncts did not detract from the learning experience. This appears to apply to the collectivists as well. Further, this suggests some variability within the implied confines of the coherence principle. Before discussing this further, it is important to finish the interpretation of results for the final statistical test results, the interaction effects, and to present the concluding discussion. A part of that discussion is a recommendation for a *flexible coherence principle*.

Interaction Effects (Cultural Dimension * Coherence Principle)

Results from a two-way analysis of variance revealed no interaction effect between the cultural dimensions and the coherence principle. This suggests that according to these results the differences and similarities in post-test scores cannot be explained by knowledge of variability in the interaction between the cultural background of a subject and the design of the module. It is more likely that culture or native language influenced achievement among collectivist subjects in post-test scores. Relevant to both interpretations, this implies that if language shapes thought, the native language and culture of the multimedia designer may influence the design and delivery of e-learning solutions and may impact the learning experience of the intended audience.

Limitations

The size of the sample overall is a limitation. While inferential statistics were used to analyze data and to detect significant differences between and among group means, it is not advisable for the research to use the results from this study to generalize to larger populations of entire cultural groups. In addition it is good to mention that small samples and short tests can make it more difficult to get statistically significant differences. The post-test used in this study only contained twelve items.

The proficiency level of English among the collectivist participants is a minor limitation, but one that deserves acknowledgement. While graduate students with high grade point averages comprised the majority of the collectivists, there was no opportunity to access each student's level of English proficiency. However, the researcher has experience in assessment, materials development, and teaching English as a Second Language (ESL) and would rate the level of English necessary to understand any of the modules as novice high or intermediate low.

Conclusion

Relative to design, development, and delivery of e-learning modules or other multimedia instructional tools the findings from this investigation inform several key areas of interest. In our diverse world it seems unlikely that a standard approach to the design of multimedia instructional content is appropriate or advisable.

Multimedia designers must reflect on the impact which their culture and language have on the design of instructional content. Specifically, a rigid interpretation of the coherence principle is not advisable. Rather, a flexible coherence principle permits the re-evaluation of multimedia design in terms of essential and non-essential instructional items. A flexible coherence principle allows for the addition of non-essential audio or image adjuncts given a consistent presentation of non-essential adjuncts and engaging instructional content. Further, the culture and native language of the multimedia designer impacts the way in which instructional content is presented. In this way, intercultural awareness implies the avowal of one's own *weltanschauung* as it relates to the way others view and interpret the world around them.

Specific advice taken from this investigation and extrapolated to online learning or computer-mediated communication includes the following examples. The manner by which time is represented online reflects a Western or individualist perspective. As discussed earlier, Confucian cultures of the collectivist cultural dimension possess vertical metaphors for time. Perhaps multimedia designers may wish to present time (duration of videos, podcasts, etc.) vertically for Confucian cultures. This is an option given the findings from this study and research from the field of cognitive linguistics.

Clearly, a normative standard of multimedia design (in this case the coherence principle) does not apply to a group of culturally and linguistically diverse learners. A flexible coherence principle requires the multimedia designer to do more work than design and develop instructional content; attention must be given to the cultural and linguistic composition of the intended audience. If such knowledge is unknown, however, it is advisable to adhere to the traditional coherence principle given the results from the controls for both cultural groups.

A flexible coherence principle would also allow for the inclusion of non-essential music or audio given the proviso that the instructional content is of interest to the learners. It may be difficult to ascertain whether a given e-learning module, for example, is going to interest its intended audiences. Generally speaking, if designing a module for a group of culturally or linguistically diverse learners it is advisable to adhere to the traditional coherence principle even though the

results from this study did not present a significant difference in post-test scores on the module with music adjuncts. This advice is based on the careful selection of the music for the module to reflect no one particular culture.

Multimedia designers should continue to draw on cognitivist contributions and the continued constructive exchange of ideas, experiences, and best practices. Given the findings from this study multimedia designers should also consider the contribution that culture, understood as not separated from language, necessarily impacts the design of instructional curricula. Common to individualist culture is the use of individual interests, competitiveness, and perspectives (Dunn & Griggs, 1995). Considering the design of multimedia instructional content, individualism may not apply to a collectivist emphasis on group cooperation. The collectivist subjects in the experiment with the module that had non-essential image adjuncts may have scored better given an opportunity to collaborate. This is not suggested as a way to make it easier for collectivist cultures; rather, this suggestion reflects the implicit nature of the collectivist cultural paradigm.

A Flexible Coherence Principle

The findings from testing the second and fourth hypothesis indicate a dichotomy. The interest-level of the module's subject matter indicates its ability to *attract* attention thus highlighting the inability of the non-essential audio or images to *distract* participants. This dichotomy explains the similarly high scores among individualist subjects in the three groups. A *flexible coherence principle* allows for the addition of non-essential audio or image adjuncts given a consistent presentation of non-essential adjuncts and engaging instructional content.

Final Reflection

In conclusion, cultural variation may be related to cognitive variation. The between and among group similarities suggest an independent universality or a dependent diversity of linguistic forms. An independent universality posits a re-affirmation of Chomskyian universal grammar. However, a dependent diversity of linguistic forms proposes a re-affirmation of a modular view of linguistic relativity. The differences and similarities between and among the cultural groups in this study suggest a dependent diversity of linguistic forms. If language has no impact on thought, scores would likely be evenly spread throughout the control and experimental groups. Individuals from different cultures are impacted not only by their own linguistic and cultural composition but also by the implied cultural and linguistic background of the multimedia designer whose instructional content may be used for educational purposes. The connection between post-test scores and linguistic investigation is rooted in the essential element of cultural variability. It is likely that an independent universality is compatible with a dependent diversity of linguistic forms. Further, an independent universality would house isomorphic structures such as the central executive and the faculty of language acquisition. A dependent diversity simply provides for variation in consumption and production of visual-verbal-aural information. The challenge is to determine the inherent proportions of this balance according to individual differences.

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