The Effects of Four Video Time-Compression Strategies, Prior Knowledge and Ear Training on Student Achievement on Different Criterion Measures

By

Joel Galbraith

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Keywords: time-compression, time-scale modification, rate-modified speech, variable speed playback, recall, comprehension, instructional video, multimedia.

I - Introduction

At a large western university, Variable Speed Playback (VSP) functionality was added to a high-enrolling, video-based accounting course. This ability to variably accelerate the video presentations was added only weeks before the semester's end, largely as a convenience for students. By semester's end, when students were surveyed about their use of VSP functionality, their responses were overwhelmingly positive. Despite the enthusiastic response, average student grades saw no change as compared with averages from previous semesters. Upon closer inspection, a much more interesting discovery was made. Although no improvement in average scores was found, students were achieving equal grades in as little as ½ the time, that is, students reported regularly viewing the instruction at up to 1.8 times (1.8x) the normal playback rate and scored no lower than students who previously viewed the material at normal speeds or attended face-to-face sections. With regard to speed, one student remarked:

> "Initially, I listened at 1.5, then at about 1.7...I hypothesize that my brain was adjusting to intaking so much information. Shortly after adjusting to 1.7, I bumped up to 2.5 with no problems whatsoever. I feel that I have really been intellectually stimulated while listening at this high speed." (Galbraith & Spencer, 2002 p.563)

By the end of the following semester, the average rate of acceleration reported by students was 2.1 times normal speed—reducing the time to view lesson materials by over half. The highest number of students reported an acceleration rate of 2.5 times normal speed. This average increase from 1.8x to 2.1x could be attributed to a number of factors with "ear training" being perhaps, the single most influential. "I found that the more I used it, the faster I could listen" wrote a student "I started at 1.5 and worked up to 1.8." (Galbraith & Spencer, 2002 p 563)

Courseware developers were left questioning if this technology was so efficient and valued by students, why it was not incorporated into much more audio- or video-based instruction in the field. Was it due to the nature of the content? Was the level of knowledge being assessed well suited to or unaffected by acceleration? Was "prior knowledge" a significant variable and if so, why did a very high percentage of students report viewing *all* segments--even segments intended for struggling students. It is these and other questions that motivate the research proposed in this document to discover what variables come to bear on how we learn with time-compressed media.

Problem Identification

Time-compression and rate-modification in general, can be used in a variety of application areas including teaching, learning and human-computer interfaces. It has been used to skim media assets, speed up message presentation in voice mail systems and in aids for the blind and used to slow down media for learning languages, or for the hearing impaired (Aarons, 1992; Omoigui, 1999). Over just the last few years, higher education and distance education institutions and programs have incorporated audio- and video-based streaming media into their instruction (Galbraith, 2000). This use of streaming media has largely taken the form of online lecture archives and presentations as a primary means of instruction or in support of other modes of instruction. Large, distributed corporations and government agencies may well be leading the charge (Arlen, 2003), with online video presentations accounting for a significant portion of corporate training. Scores of inexpensive products and services exist in the market today that facilitate the simple and even fully automatic creation and distribution of rich streaming media and video presentations for education and training purposes.

Radio and television networks have understood and employed time-compressed programming for decades as a means of selling more air time for advertisers (Labarbera & MacLachlan, 1979). Where instructional efficiencies are desirable in terms of time, the concept of time-compressed presentations has also long been an alluring goal in training and education. A body of research exists (Orr, Friedman & Williams, 1965; Harrigan, 1995, 2000; Short, 1977; Olson, 1985, King & Behnke, 1989), suggesting equally effective learning with time-compressed or accelerated video presentations as with normal speed presentations. Outside of the, perhaps obvious, time-savings benefits, little is known about what type of learning objectives/tasks or memory is affected by time-compression. Little is known about what interactions exist among prior knowledge, ear training and learning under different acceleration conditions. Lastly, little appears to be known about how acceleration conditions may affect user preferences and usage patterns.

Research Questions & Hypotheses

For college students viewing instructional video presentations, controlling for natural speaking speed (words per minute-wpm), content and ear training effects:

RQ_1: What is the relationship among different time-compression conditions, level of prior knowledge and participant performance on different criterion measures?

> H_1: There will be no significant differences in performance on various measures among participants experiencing different time-compression conditions.

H_2: There will be no significant differences in performance on various measures among participants experiencing different time-compression conditions, possessing different levels of prior knowledge.

RQ_2: What is the relationship among different time-compression conditions, test performance, prior knowledge levels and time efficiencies?

H_3: There will be no significant differences among overall participant performance, time-compression conditions and gained time efficiencies.

Assumptions & Delimitations

It is assumed that video instruction will be supplemented with supporting graphics across all treatments. It is also assumed that all participants will be proficient in English, and that no participants will have hearing impairments, such that audio is unintelligible. For many of the participants, it is assumed that they will have had at least 20 hours of conditioning to accelerated presentations. This is to be expected as participants will be drawn from a large course currently employing accelerated media in the instruction.

Definition of Terms

Term	Definition
Time-scale modification, Rate-modified speech.	Used in the technical signal processing literature to describe time-altered audio. (slower or faster)
Time-compressed audio,	Used in the psychology literature to describe accelerated audio. The alternate is referred to as "time-expanded" audio.
Variable Speed Playback (VSP)	The ability for users to dynamically change playback speed.
Identification test	Measures student's ability to identify parts or positions of an object by correctly numbering parts on a detailed drawings
Terminology test	Measures student's knowledge of specific facts, terms, and definitions.
Comprehension test	Measures student's understanding of the heart, its parts, its internal functioning, and the simultaneous processes.
Words Per Minute (wpm)	Normal speaking ranges from 120-180 words per minute
Ear Training	The acclimation and comfort level achieved with time-compressed media after prolonged exposure.

Study Significance & Generalizability

Acceleration and time compression studies from the early 1950s to the late 1970s focused primarily on the comprehension of audio. With the settling of this research field over the past couple decades, combined with the emergence of the Internet, there is a need to verify if previous findings still hold true for audio- and video-based instruction in this environment. Given the current interest in media-rich distance education, understanding the potential negative and positive effects of acceleration on learning is critical. Furthermore, increased understanding of how people respond to and use time-compression is important for the design of learning environments and interfaces.

Since presentation acceleration can be applied to any video content, study results should be widely applicable to many domains where the audio is the primary message carrier or channel. Exceptions may exist with entertainment media (Omoigui et al. 1999), certain music instruction and with other time-sensitive or highly-detailed visual content. Additionally, implications exist for designers of audiobook hardware and software players. Many commuters and business travelers regularly listen to motivational and training materials. Unlike the mechanical audio cassette devices common in years past, the functionality in new digital devices to electronically accelerate media is very rare.

The instructional content used in this course (Dwyer Heart content) is likely to be of general interest to all students. It is unreasonable to assume that interest in this subject matter is unique to those pursuing instruction in physiology. Participants for the study will be drawn from a large general education class and come from multiple backgrounds, majoring in varying fields of study. Findings should be generalizable to similar types of students in other programs or at other comparable educational institutions.

II - Review of Research & Literature

Acceleration

The interest in accelerated audio or video presentations has existed for some time, but research appears to have slowed down during the past decade as more media moved to the web. The functionality to accelerate audio once found in reel-to-reel and cassette tape systems, and more recently in computer-based systems, was not readily available for web-based media, and had not caught on commercially (Aarons, 1992). The fierce desktop media player wars of the 1990s were highly focused on entertainment and music for which there is generally little use or desire for acceleration. Thus time-compression functionality has only recently been made widely available in the form of player plugins (Enounce Inc.) or in Microsoft's case, the functionality was just added to their most recent Windows Media 9 architecture. Due to recent these technological as well as time-compression algorithm advances, it could be argued that the ability to accelerate media and retain high intelligibility has never been so widely available as it is today.

In normal conversation, people speak and can comfortably hear words that are spoken at between 120 to 180 words per minute (Williams, 1998; Silverstone, 1974). Moderately accelerated presentations have been shown to benefit learning as long as intelligibility can be maintained (Harrigan, 2000; Short, 1977). When this normal speech is increased to 210 words per minute, there is still no loss in comprehension (Omoigui, He, Gupta, Grudin, & Sanocki, 1999). A 1965 study (Orr et al) noticed that listeners could tolerate acceleration up to 2.0x normal speed (twice as fast). They and others note that with ear training and practice, even higher speeds (400 wpm) were possible as with visually impaired individuals, for example (Voor, 1965; Aarons, 1992; Silverstone, 1974).

“This creates a speaking/listening discrepancy since a listener can comprehend spoken material up to four times (4x) faster than the speaker can send the message” writes Olson. “The result is a listener [or learner] who becomes bored or whose attention begins to wander (1985 p.3).” Students themselves have reported anecdotally that accelerated presentations help them speed through boring or redundant material. They say it helps them stay more focused and attentive, learn more, get higher grades. Some research appears to bear out the aforementioned student comments under certain conditions (Harrigan 1995, 2000; Gutenko, 1995). Finally, studies in the field of communications suggest that fast speakers are perceived as more intelligent, authoritative, competent, articulate, interesting and memorable than slow speakers (Ananova, 11/15/2002; Storck, 1995; Gutenko, 1995; Labarbera & MacLachlan, 1979).

On a technical note, many of the studies from the 1950s to the 80s employed destructive time-compression techniques that “involved deletion and subsequent concatenation of portions of the acoustical signal.”(Dupoux & Green, 1997) Much improved time-scale modification (compression) algorithms tend to be far less disruptive to speech as they overlap, rather than delete portions of the signal. Generally, it can be expected that today’s signal processing and time-compression algorithms should facilitate higher comprehension than previous technologies and techniques given comparable wpm rates.

Information Processing

Not all the research is so positive, and time efficiencies are not always the prime concern at schools or even corporate environments. Media Richness theory (Daft, Lengel, & Trevino, 1987) suggests than richer media can reduce ambiguity in conveying messages (El-Shinnamy & Markus, 1998), and can help audiences converge on a shared meaning. Information Processing (IP) theories including limited capacity models (Lang, 2000) and Dual Coding theory (Paivio, 1979), question or temper the "more is better" approach. "Parallel processing models acknowledge that a person can simultaneously engage in multiple tasks, such as seeing and hearing, depending ion whether the tasks require the use of separate or common resources (Leigh, 1991, p. 72)." Again, Media Richness adherents value the multimodal, multi-channel (rich) approach to instruction inherent in most video presentations, but the theory does not account for issues of acceleration or specific learning objectives beyond this reduction of message ambiguity. But outside of the, perhaps obvious, timesavings benefits, little is known about what type of learning objective or memory is affected by time-compression.

In her literature review of IP capacity, channels and modality, Hsia (1971) makes two particularly noteworthy points: A) Human information-processing functions as a multi channel system until the capacity of the system is overloaded, at which point it reverts to a single channel system. B) An increase in the amount of information or stimuli presented, does not necessarily increase the rate of information encoding and storage. For example, much research suggests that intelligibility declines for users at some point of acceleration, directly compromising comprehension and memory. (Carrol, 1968; Heiman, 1986; Beasley, Bratt, & Rintelmann, 1980). In another example, King and Behnke's (1989) tests found that while short term and interpretive listening test scores (Kentucky Comprehensive Listening Test) did not decay until high levels of compression were reached, comprehensive listening scores and long term memory linearly declined with speed increases. This might be attributed to the lack of processing time available for long term memory processing, and the rapid turnover of information in short term memory.

Many of the studies cited thus far have dealt with simple media representations (usually audio only) and did not factor in the additional cues and associated encoding demands of the even richer multi-modal interfaces described in this proposal. The complexity of the stimulus materials and density of ideas presented are very relevant factors when it comes to time-compression and comprehension. IP theory holds generally that complex material would be adversely affected by high rates of time-compression due to overloading and subsequent over-writing of short term memory. (Moore, Burton & Myers, 1996) Along related lines, Limited Capacity models describe the allocation of resources (both voluntary and automatic) to given stimuli (Lang, 2000). Lang describes numerous conditions affecting orienting response and cognitive resource allocation relevant to video presentations, and how they are affected by the goals and needs of the individual—whether they are viewing for pleasure/relaxation or for learning. The highly attending learner/viewer is likely to run into resource-limited situations, but due to conscious increases in applied resources, the learner is still likely to process the message more fully (Lang 2000).

On the other hand, Cue Summation models hold that multimodal instruction can aid in learning. Olson's (1985) work can be best framed in this cue summation (Severin, 1967) context. She focused on what visual and textual augmentation stimuli might be applied to help mitigate these overload effects and "allow the faster compression rates to be as effective as a normal rate (1985, p.6)." A level of additional stimuli (textual script or simple visuals) might provide the redundancy needed to comprehend the spoken material and "provide enough additional information for the learner to organize or restructure the material (p. 6)." It is difficult to know if such visual augmentations exacerbate problems associated with limited capacity models of cognition, or if they in fact aid in the coding of the message. Hsia (1968) like others conclude that if channels present highly redundant material, then the overloading point is not reached as quickly as when between-channel redundancy is low.

Olson (1985) also employed the same Dwyer Heart script and tests (criterion measures) proposed for use in this study. She looked specifically at the effect of her independent variables on spatial restructuring, terminology, identification and comprehension tests. She concludes that acceleration (250 wpm) affects different learning objectives or tasks in different ways. More specifically, acceleration had no significant effect on any but the terminology test, in which normal presentation rates were superior. Her visual channel augmentations (despite being highly redundant) seemed only to make a difference where they were relevant to the required learning task. In light of these points, it appears that in Olson's study, attempting to code the precise details or complex terminology of the content was adversely affected whereas the other learning tasks did not overload student' short term memory or IP abilities sufficiently to hinder coding and recall. The location of parts (identification test), overall gist (spatial and comprehension tests), was not adversely affected with that amount of time-compression either.

User control & variable speed playback

User control of playback speed is also known as Variable Speed Playback (VSP). It differs from fixed rate acceleration in that users can dynamically adjust video presentation speed to individually comfortable rates. Users may wish to adjust playback speeds multiple times based on the presentation topic, the user's prior knowledge or familiarity with the subject matter, the presenter's diction, the density of concepts or level of detail in the presentation, or in order to catch a bus on time—in short, for any number of reasons. The general superiority of VSP over fixed rate acceleration is substantiated by multiple reports (Cohen, Amir, Ponceleon, Blanchard, Petkovic, Srinivasan, 2000; Harrigan, 2000; Omoigui, 1999; Short, 1977; Zemlin, Daniloff & Shriner, 1968), and this study will seek to further refine such findings as they relate to usage habits, preferences. It is hypothesized in this study that the user-controlled, variable-speed playback condition may significantly mitigate the negative effects of cognitive overload if participants are found to use acceleration to their advantage. Put another way, participants who accelerate through portions where they have high prior knowledge and who can self monitor enough to slow down again for complex or cognitively taxing material, might experience time efficiencies and/or higher scores over participants in fixed-rate or non-accelerated conditions. It may prove difficult however, to unobtrusively ascertain participant usage patterns, and motivations for adjusting acceleration rates.

Prior Knowledge

Prior knowledge is also believed to an important variable with relation to time-compressed presentations and usage patterns employed by users. It may be evident that those with high prior knowledge are likely to do better on posttests than others. While this finding is expected, numerous other issues may also be at play. Will those with high prior knowledge realize significant time savings (efficiencies) both in terns of viewing time and actual time over those with lower prior knowledge in the variable condition? Will they be adversely affected (emotionally?) by having to “endure” normal or moderate speeds if they are already ear-trained? To what degree will those with low prior knowledge benefit from different time-compression conditions?

Simply put, it is expected that those with even superficial prior knowledge of the heart will be able to sustain higher rates of acceleration as incoming information will be more easily recognized by sensory registers and spend less in short term memory’s (STM) maintenance rehearsal holding pattern (Moore, Burton & Myers, 1996). The information will be more efficiently encoded into existing schema facilitating better storage in long term memory (LTM). Literature shows that (Dick & Carey, 1990; Dwyer, 1972) the reduction of irrelevant cues and information can increase the effectiveness of instructional materials. To some degree, higher acceleration conditions may act as a form of selective reduction of extraneous cues and information for those possessing high prior knowledge. These same conditions will likely not serve those with low prior knowledge as effectively. Implications exist for the many institutions and programs that currently archive or wish to archive their lectures and presentations. Archived lectures and discussions may make for effective study tools as they may be replayed at high rates of acceleration as a rehearsal strategy for those with who already attended the original lecture. Additionally, archives that can be reviewed at accelerated rates may benefit those wishing simply to “fill in” gaps in their knowledge without taking or retaking a training program or course for which they possess a great deal of prior knowledge.

Ear Training

Ear training, conditioning and acclimation to time-compression is expected to play a critical role in how people respond to and learn from accelerated presentations. Informal evidence indicates that people react tentatively to viewing and hearing highly time-compressed media--perhaps due to a novelty effect. Tellis (1997, p. 76) argues, “When subjects first see novel stimuli, the novelty leads to uncertainty and tension.” People need time to acclimate to acceleration. It is implied, if not explicitly stated in most all of the time-compression research reviewed, that one’s ability to improve comprehension can be increased with practice and exposure. Both empirical and extensive anecdotal evidence point to fairly rapid normalizing effects when listening to time-compressed speech. Beasley & Maki (1976), for example discuss how people’s perception of what “normal speed” is and their preference for accelerated presentations, both increase with prolonged exposure to time-compression. When accelerated presentations are returned to their recorded (normal) speed, people perceive the presentation to be artificially slowed down below “normal” rates (Omuigui et al., 1999). Galbraith & Spencer (2002) collected similar expressions from hosts of students in their survey study. In addition strong negative reactions have been expressed when returning to normal speed where the “pace may seem dreadfully slow” (Fulford, 1993 p.51)

Terminology, Identification and Comprehension Tests

The following dependent measure information is taken from Dwyer’s Handbook for the Effective Selection, Design and Use of Visualized Materials. (1978, pp 46-47) A fourth test, a drawing test, is commonly used with Dwyer’s heart content, but is not deemed necessary for the purposes of this study, and will not be further discussed.

Terminology Test

This test consists of 20 multiple-choice items designed to measure the student’s knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas which require a comprehensive understanding of the basic elements (terminology, facts, and definitions) before more complicated types of learning can occur. Such are the conditions for the Dwyer Heart Content.

Identification

The objectives of the identification test are to evaluate student ability to identify parts or positions of an object by correctly numbering parts on a detailed drawing of a heart. The objective of this multiple-choice test (N=20 items) is to measure the student's ability to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper name. Tests similar to the identification test could be used in any course in which the student is required to be able to locate and identify the various parts of objects.

Comprehension Test

The comprehension test consists of 20 multiple-choice items. Given the location of certain parts of the heart at a particular moment of its functioning, the student is asked to locate the position of other specified parts of the heart at the same point in time. This test requires that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test is designed to measure a type of understanding that occurs when the individual can use the information being received to explain some other phenomenon occurring simultaneously (Dwyer & De Melo, 1983). Tests similar to the comprehension test can be used in any discipline area in which the objective is to measure the student's understanding of complex procedures and processes.

The hierarchy of knowledge needed to correctly answer this type of comprehension question is evidenced by the need for students to first be familiar with the terminology used to describe the heart. Then, they must be able to recollect the location of the various parts of the heart and be able to position the individual parts of the heart in their "minds eye" as they relate to one another. Furthermore, they must also be able to mentally simulate the functions and movements of the various parts of the heart as they would occur during different phases of the heart. Only when the students have acquired a comprehensive understanding of the content material, can they consistently respond correctly to the type of questions contained in the comprehension test.

Total Criterion Test

The items contained in the three individual criterion tests are combined into a 60-item total criterion test. The purpose of this test is to measure the student's total understanding of all the content material presented in the instructional unit. Students will be given the identification test first, followed by the terminology test, with the comprehension test being administered last. Each participant is permitted to take as much time as s/he requires to complete one criterion measure before proceeding to the next, however, each individuals start and stop time is recorded.

Test Reliability, Validity and Generalizability

A Kuder-Richardson Formula 20 Reliability coefficient for the four criterion measures was computed for a random sampling of Dwyer Heart content studies prior to 1978. An average reliability coefficient for each criterion test was computed; they are: .83--terminology test, .80--identification test, .77--comprehension test, and .92--total criterion test. More recent reliability data will be sought for the tests, but there is little reason to expect much variance from this data as scores of studies have used the Dwyer Heart content and associated criterion tests (Dwyer, 1978). Validity will be further reviewed with this specific delivery system and supporting graphics during pilot testing with a group of students from the target population.

As outlined above, the criterion tests assess different types or levels of learning. The degree of achievement on higher-level cognitive tasks is directly related to the quality and quantity of learning achieved in the prerequisite, lower-level tasks. This process is the same, regardless of discipline, where similar types of objectives are to be achieved. The more terms and concepts a person possesses, the easier it is for him to form generalizations, rules and so forth (Dwyer, 1978).

Time Efficiencies

Those applying technologies to training and education have always sought for the perfect medium, one that delivers instruction so that learning is both effective and efficient (Fulford, 1993). Time efficiencies are at the root of much of the research in this field. In measuring time, however, one cannot simply tally the length of the video presentations themselves. Fulford cautions that “It is not enough to assume that because the overall effectiveness was equivalent to normal speech and the word rate was faster, the result is greater efficiency (p. 58).” Actual time (viewing and tests) as well as viewing time (without tests) must be calculated for each participant.

Time efficiencies are also not universally reported or are not sufficiently clear. According to Sticht (1969), listening to instructional material twice that has been accelerated by a factor of two, is more effective than listening to it once at normal speed. In such cases, obviously no time savings are realized. Fulford reports that even with the ability to rewind and repeat instruction, that accelerated presentations were more efficient. Usage habits—the ways in which participants navigate, repeat sections, stop and start are seldom found in the literature, but few participants appear to be given control over the media. These user control features including variable speed playback ability, further complicate the matters of time reporting and tracking. Students may report regularly accelerating to twice the normal speed (2x), but may in fact only do so when they accerlerate at all. It may be that during large portions of the content, they don't accelerate or they pause to "digest" or process information for a time. Here too, although the student may report accelerating to 2.x s/he has not realised an overall 50% savings in time. At least one study (Omoigui et al., 1999) does track VSP use by participants over multiple days, and across five different types of video material. Researchers tracked how often and in which direction users adjusted speeds. One interesting finding was that in videos that included concluding remarks or summary statements, participants were observed to slow down or repeat such summary segments. More of this type of research should be conducted (Omoigui et al., 1999). Logging actual and viewing time separately should allow researchers to discover if correlations exist between speed conditions and time spent taking tests--a variable also not found in the research.

Summary

A good amount of research has been conducted in this field dating back to over 50 years. In that time, tools and time-compression techniques have changed, as has our storage and playback media. The primary delivery mechanisms have also changed significantly from ones dominated by linearity to one dominated by its lack of linearity (the Internet). Internet technologies support the ability to randomly access even traditionally temporal media forms like audio and video. It is believed that today's combination of accelerated streaming media with web-based hypermedia sets the stage for affordances and usage patterns not researchable with previous technologies?

Interest in and use of web-based multimodal media is growing with streaming video presentations to be found at the high majority of higher education institutions explored (Galbraith, 2000). It is highly unlikely that acceleration is being utilized in these settings. This study proposes to explore the instructional effects of accelerated video presentations on learners, specifically due to the only recent wide-spread availability of time-compression software for web-based media. It is believed the outcomes of this research will significantly contribute to the field and on a more practical note, help instructors, trainers and instructional designers more fully understand the issues surrounding presentation acceleration in both face-to-face instruction and distance education settings.

Numerous other variables exist in the research that relate to video and acceleration like screen size, presenter attractiveness, gender and age. Perhaps the most salient of these is aging adults and their limited tolerance and capacity for processing time-compressed media. These variables are however, not within the scope of this study.

III – Design of the Study

Materials & Procedures

Dwyer's Heart script is a 2,000 word instructional unit on the human heart, its parts, and the internal processes that occur during the systolic and diastolic phases. It was developed over 20 years ago and has been tested and used in scores of studies. It was selected because it provides a consistent way of studying knowledge acquisition from simple learning of basic facts to more complex comprehension and problem solving abilities.

The text script will be minimally altered for the purposes of video recording and presentation. While no script content will be deleted, language will be added to lend a more natural and conversational tone for the professional narrator. The Narrator will read the script from a teleprompter. The video will subsequently be scaled down and (digitally) compressed for integration with the supporting visuals. The VSP abilities of the Microsoft Windows Media player (v 9.x) will be utilized for all acceleration conditions.

The supporting visuals will comprise of largely stills and simple animations achievable within Microsoft PowerPoint. Visualization ideas will come from previous studies dealing with visualization of the Heart content. Completed stills and animation will be synchronized with the video using Microsoft Producer. Media will be presented to participants on a one screen interface in a simple, 2-frame format (instructional video in the left and synchronized media on the right). Media controls (play, pause, volume, speed control*) will be located directly below embedded video frame.

Pilot tests will be conducted to determine and validate discerning and optimal fixed-acceleration speeds for this particular population, content and methods. Currently fixed-acceleration points assume a 160 wpm normal speed (1x), with 1.3x and 1.7x corresponding to 208 wmp and 272 wpm respectively.
*Only the variable speed group will see speed controls.

Criterion Measures & Data Collection

General data collected:

1. Gender

2. Computer number
3. Native English speaker?
    a. If no: how many years in primarily English speaking environment?

Data collected from assessments:

1. Prior Knowledge Test – assesses participant's existing knowledge of general physiology and the heart, while taking measures not to cue for subsequent testing.
2. Identification Test – assesses knowledge of parts or positions of an object.
3. Terminology Test – assesses knowledge of facts, definitions and concepts.
4. Comprehension Test – assesses whether participants have a solid understanding of the concepts.
5. Total – a combination of the Identification, terminology and comprehension tests.
6. Speed preference (normal vs. fixed accelerated vs. variable) – a simple survey question as to participant preference with an free-form "please explain" field.
7. Usage pattern data – based on self-reporting and researcher observations.

Instructional Treatments

Fig 1

Independent Variables	Description
1) Time-compression strategy	
Normal Speed	Participants view video at regular speed (**1x**), corresponding to approximately 160 words per second. Video presentations can be stopped, paused, and any portions can be replayed. This treatment, like all the others, includes supportive graphics all embedded within a single webpage.
Fixed Moderate Acceleration (to be determined in pilot tests)	Participants view video at a fixed rate of acceleration (**1.3 times normal speed**), corresponding to approximately 208 words per second. Video presentations can be stopped, paused, and any portions can be replayed. This treatment, like all the others, includes supportive graphics all embedded within a single webpage.
Fixed High Acceleration (to be determined in pilot tests)	Participants view video at a fixed rate of acceleration (**1.7 times normal speed**), corresponding to approximately 272 words per second. Video presentations can be stopped, paused, and any portions can be replayed. This treatment, like all the others, includes supportive graphics all embedded within a single webpage.

Variable Speed (User control)	Participants can opt to view video at any speed from .3 times normal speed (48 wpm) to 2.5 times normal speed (400 wpm). Here too, video presentations can be stopped, paused, and any portions can be replayed. This treatment, like all the others, includes supportive graphics all embedded within a single webpage.
2) Prior Knowledge	
High	Participants exhibiting high levels of prior knowledge of heart functions on pretest.
Low	Participants exhibiting low levels of prior knowledge of heart functions on pretest.
3) Ear Training	
Yes	Participants have many hours of experience (ear training) with accelerated presentations.
No	Participants undergo experiment on first day of class and have no prior experience with accelerated presentations.

Dependent Variables	Description
1) Student Achievement	
Identification	Measures student's ability to identify parts or positions of an object by correctly numbering parts on a detailed drawing of a heart.
Terminology	Measures student's knowledge of specific facts, terms, and definitions
Comprehension	Measures student's understanding of the heart, its parts, its internal functioning, and the simultaneous processes.
Total (combined)	Combined score of all measures.
2) Time for completion	
Viewing time	How much time was taken to view treatments before posttest
Actual time	How much time was taken to complete treatments and posttests (total)

Potential Covariate: (to be reviewed during analysis of collected data)

1. Treatment condition preference

Experiment Design:

This study employs a 2x2x4 factorial design. (see fig. 2)

Participants

College students (n=420) at a large western university enrolled in a elective general education course will still be asked to volunteer according to IRB guidelines. Alternate assignments will be developed in collaboration with the instructors for those students who do not wish to participate. Access to students is believed to be feasible for the duration of the experiment.

Each participant will be tested on their prior knowledge and then using stratified assignment, they will be equally distributed (n=60) into each of the four time-compression conditions: normal, accelerated (moderate, high) and variable speed. Each participant will view the presentation being played at the speed to which s/he is assigned.

Fig 2

	ID #	Prior Knowledge & Ear Training (ET)	Prior Knowledge & No Ear Training (ET)
Normal (1x) [n=60]	1	High (n=30)	n/a
	2	Low (n=30)	n/a
Moderate Acceleration (1.3x) [n=60]	3	High (n=30)	High (n=30)
	4	Low (n=30)	Low (n=30)
High Acceleration (1.7x) [n=60]	5	High (n=30)	High (n=30)
	6	Low (n=30)	Low (n=30)
Variable (~?x) [n=60]	7	High (n=30)	High (n=30)
	8	Low (n=30)	Low (n=30)

Materials

Fig. 3

Item	Purpose	Description
Video clip 1	Intro (brief ear training)	Some instructional segment of universal interest
Video clip 2	Main instrument	Dwyer Heart Content w/supporting visuals
Video clip 4	Preference test	Short segment from Heart content following all 3

		conditions
Supporting visuals	Complement audio (redundant information)	Simple Flash or Powerpoint illustrations.
Pretest	Test prior knowledge	Basic physiology and heart or circulatory system test
Criterion measures	Test effects	The written criterion measures

Procedures

1. Distribute and collect informed consent forms and Pretests to class on first day of class.
2. Random assignment of viewing condition to participants (see Fig. 6)
    - Participants are unaware of speed condition to which they are assigned until they read their on-screen directions. They will simply be asked to carefully view video instruction on the heart and be prepared to answer content questions following the viewing.
    - Lab computers, previously configured, will be set up with the video materials and assessment items.
3. Setup and explanation for **"No-Ear-training"** group
4. Ask each person individually if they have any questions
    - Those who do not wish to participate receive alternate assignment
5. Participants launch the protocol (see Fig. 4)

Fig 4

<table>
<tr><td rowspan="2">Normal (1x) [n=60]</td><td rowspan="4">Instructions</td><td colspan="4">Note: videos clips will be edited into one (single) segment per treatment</td><td rowspan="4">Post-tests</td><td rowspan="2">Total time 16:12</td></tr>
<tr><td>Intro video (1:00)</td><td>Title (:06) "Video clip #1"</td><td>Video #1 (15:00)</td><td>Title (:06) "End"</td></tr>
<tr><td>Moderate Acceleration (1.3x) [n=60]</td><td>Intro video (:48)</td><td>Title (:06) "Video clip #1"</td><td>Video #1 (12:38)</td><td>Title (:06) "End"</td><td>Total time 13:30</td></tr>
<tr><td>High Acceleration (1.7x) [n=60]</td><td>Intro video (:39)</td><td>Title (:06) "Video clip #1"</td><td>Video #1 (9:09)</td><td>Title (:06) "End"</td><td>Total time 10:00</td></tr>
</table>

Variable (~?x) [n=60]		(~:37)	Title (:06) "Video clip #1"	Video #1 (~11:12)	Title (:06) "End"		time **~12:00**

6. Participants proceed to preference survey (see Fig. 5)

Fig. 5

All speed conditions	Instructions	***non-sequential***				Preference survey	Max time **~6:20**
		Video #3 (2:00) **Normal**	Video #3 (1:45) **Moderate Acceleration (1.3x)**	Video #3 (1:12) **High Acceleration (1.7x)**	Video #3 (~1:20) **Variable**		

7. Video 1 – Primary treatment (Dwyer Heart Content)
   - Take Identification, terminology and comprehension tests
   - Presentation speed preference assessment (see fig. 5)
     - 2 minutes
8. Save data & confirm proper operation of program prior to logging off lab computers
   - 1 minute
9. Debrief participants as a class.
   - Time as needed (5 minutes max.)
10. Follow steps 3-9 for "**Ear-training"** group after 2 weeks of ear training/conditioning.

Researcher Qualifications

Mr. J. Galbraith worked for seven years as an instructional media designer and producer at Brigham Young University. He has garnered numerous regional and national awards for his work including being named to AV Video Multimedia Producer magazine's top 100 media producers list for 2002. Mr. Galbraith has a BA in film and an MS in technology education from BYU and is currently pursuing a Ph.D. in Instructional Systems from Penn State University.

Timeline & Budget

General Schedule:

Data for this study will be collected in two stages. The ear training group will finish at the soonest 2 weeks following the non ear-training group who start on the first day of class. Time for experiment should not exceed one hour twenty minutes.

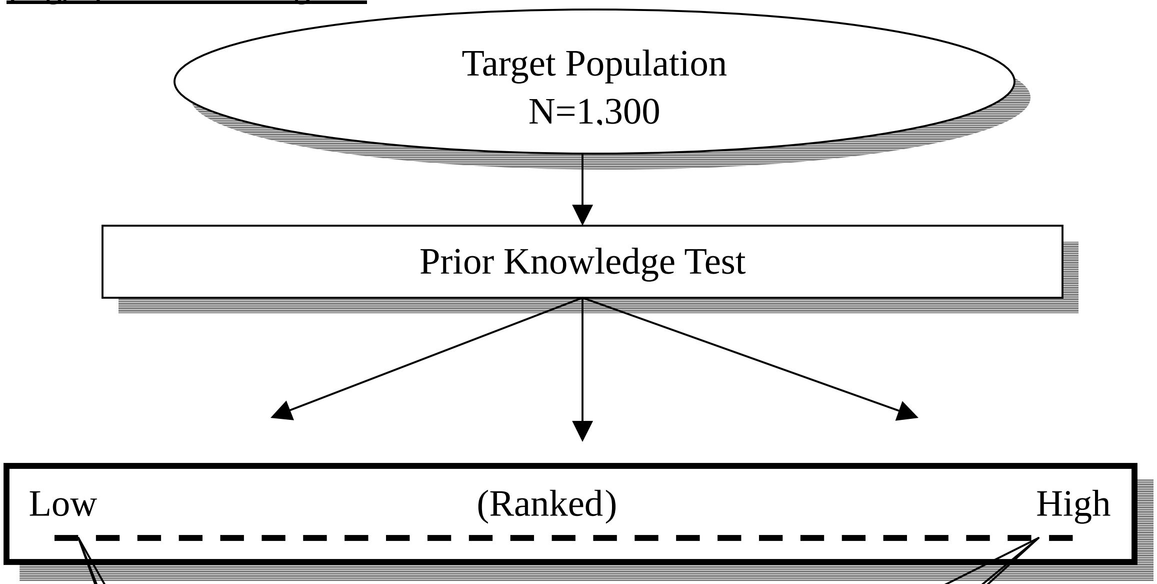
- IRB approval will be needed from both BYU and PSU.
- Pilot tests to determine fixed-acceleration speeds (1.3x?, 1.7x?)
- Pilot tests to determine quality of stimulus materials (Video and visuals)
- Locate on-camera talent for presentation of heart content script.

Budget:

Budget will include Travel to Brigham Young University (Utah) where experiment will be conducted. No accommodation or meal allowance will be required. Additional amounts will be needed for the following (to be determined):

- $300 for professional on-camera presenter (deliver heart content script)
- Tests, instructions, release form printing
- CDrom burning of materials (450 copies)
- Pencils to fill out tests
- Scantron forms (or build an online assessment)
- Potentially 2 pizza parties (180 and 240 participants)
- Rewards for pilot participation (pizza?, cash?)

(Fig,.6) Research Diagram



*

Treatment						
Normal (60)	H (30)	NONE (30)**	H	NONE	H	NONE
	L (30)	NONE (30)	L	NONE	L	NONE
Moderate fixed (120)	(60)					
		NONE (30)				
	L (60)	EAR (30)	L	EAR	L	EAR
		NONE (30)		NONE		NONE
High Fixed (120)	H (60)	EAR (30)	H	EAR	H	EAR
		NONE (30)		NONE		NONE
	L (60)	EAR (30)	L	EAR	L	EAR
		NONE (30)		NONE		NONE
Variable (120)	H (60)	EAR (30)	H	EAR	H	EAR
		NONE (30)		NONE		NONE
	L (60)	EAR (30)	L	EAR	L	EAR
		NONE (30)		NONE		NONE

* Participants are equally distributed across treatments

** The normal (control) treatment requires no ear-training, so fewer participants are needed.

References

Ananova. (2002, November 15, 2002). *US sitcom stars told to speak faster* [webpage]. Ananova. Retrieved May 2, 2003, from the World Wide Web: http://www.ananova.com/entertainment/story/sm_710061.html

Arlen, G. (2003). *For Tech's Sake: Video's Growing Role In Government Services*. Washington Technology. Retrieved April 25, 2003, from the World Wide Web: http://washingtontechnology.com/news/1_1/for_techs_sakes/20605-1.html

Arons, B. (1992). *Techniques, Perception, and Applications of Time-Compressed Speech: Proceedings of 1992 Conference of the American Voice I/O Society.* Paper presented at the American Voice I/O Society.

Beasley, D. S., Bratt, G. W., & Rintelmann, W. F. (1980). Intelligibility of time-compressed sentential stimuli. *Journal of Speech and Hearing Research, 23*, 722-731.

Beasley, D. S., & Maki, J. E. (1976). Time- and Frequency-Altered Speech. In N. J. Lass (Ed.), *Contemporary Issues in Experimental Phonetics* (pp. 419-458). New York: Academic Press.

Cohen, G., Amir, A., Ponceleon, D, Blanchard, B., Petkovic, D., Srinivasan, S. (2000). *Using Audio Time Scale Modification for Video Browsing.* Paper presented at the 33rd Hawaii International Conference on System Sciences.

Daft, R. L., Lengel, R. H., & Trevino, L. K. (1987). Message equivocality, media selection and manager performance: Implications for information systems. *MIS Quarterly, 11*, 355-366.

Dwyer, F. M. (1978). Strategies for improving visual learning: A handbook for the effective Selection, design and use of visualized materials. State College, PA: Learning Services (pp. 44-49)

Dwyer, F. M. & De Melo, H. (1983). The effect of visual testing in assessing the instructional potential of variables associated with visualized instruction. *Journal of Instructional Psychology. 10 (3), 126-41*.

Dupoux, E., & Green, K. (1997). Perceptual adjustment to highly compressed speech: effects of talker and rate changes. *Journal of Experimental Psychology: Human Perception and Performance., 23*(3), 914-927.

El-Shinnawy, M., & Markus, M. L. (1998). acceptance of communication media in organizations:richness or features. *IEEE Transactions on Professional Communication, 41*(4), 252-253.

Foulke, E., & Sticht, T. G. (1971). The perception of time compressed speech. In D. Horton & J. Jenkins (Eds.), *Perception in language* (pp. 79-107). Pittsburgh, PA: Pittsburgh University Press.

Fulford, C. P. (1989). *the relative effectiveness and efficiency of systematically designed* *instructional text augmented with normal and compressed speech audio tapes.* Unpublished Ph.D., The Florida State University, Tallahasse.

Fulford, C. P. (1993). Can learning be more efficient? Using compressed speech audio tapes to enhance systematically designed text. *Educational Technology, 33*(2), 51-59.

Galbraith, J. (2000). *Using New Internet Technologies to Enhance the Effectiveness of Asynchronous Video-Based Instruction.*, Brigham Young University., Provo, UT.

Galbraith, J., & Spencer, S. (2002). *Variable Speed Playback and Video-Based Instruction: Is Faster Better?* Paper presented at the EdMedia, Denver, CO.

Gutenko, G. (1995). *Speed: "Run"- Time Compressed Video for Learning Improvement and Digital Time Compression Economy.* Retrieved March 24, 2003, from the World Wide Web: Eric Document, ED384 341.

Harrigan, K. (1995). The SPECIAL system: Self-paced education with compressed interactive audio learning. *Journal of Research on Computing in Education, 27*(3), 361-370.

Harrigan, K. (2000). The SPECIAL system: Searching time-compressed digital video lectures. *Journal of Research on Computing in Education, 33*(1), 77-86.

He, L., Grudin, J., & Gupta, A. (2000). *Designing Presentations for On-Demand Viewing.* Paper presented at the Paper presented at CHI 00, 2000, Association for Computing Machinery, Hague, Netherlands.

Heiman, G. W., Leo, R. J., Leighbody, G., & Bowler, K. (1986). Word Intelligibility Decrements and the Comprehension of Time-Compressed Speech. *Perception and Psychophysics, 40*(6), 407-411.

Hsia, H. J. (1968). On channel effectiveness. *AV Communication Review, 16*, 245-267.

Hsia, H. J. (1971). The information processing capacity of modality and channel performance. *AV Communication Review, 19*(1), 51-75.

King, P. E., & Behnke, R. R. (1989). The Effect of Time-Compressed Speech on Comprehension, Interpretive and Short-Term Listening. *Human Communication Research, 15*(3).

LaBarbera, P. A., & MacLachlan, J. (1979). Time-Compressed Speech in Radio Advertising. *Journal of Marketing, 43*, 30-37.

Lang, A. (2000). The Limited Capacity Model of mediated message processing. *Journal of Communications, 50*(1), 46-70.

Leigh, J. H. (1991). Information processing differences among broadcast media: review and suggestions for research. *Journal of Advertising, 20*(2), 71-75.

Moore, D., Burton, J., & Myers, R. (1996). Multiple channel communication: The theoretical and research foundations of multimedia. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology*. Mahwah, New Jersey: Lawrence Earlbaum.

Olson, J. S. (1985). *A Study of the relative effectiveness of verbal and visual augmentation of rate-modified speech in the presentation of technical material.* Paper presented at the Annual Conference of the Association or Educational Communications and Technology (AECT), Anaheim, Ca.

Omoigui, N., He, L., Gupta, A., Grudin, J., & Sanocki, E. (1999). *Time-Compression: Systems Concerns, Usage, and Benefits.* Paper presented at the CHI 99, 1999, Association for Computing Machinery, Pittsburgh, PA.

Orr, D. B., Friedman, H. L., & Williams, J. C. (1965). Trainability of listening comprehension of speeded discourse. *Journal of Educational Psychology, 56*, 148-156.

Paivio, A. (1979). Imagery and Verbal processes. Hillsdale NJ: Erlbaum.

Severin, W. J. (1967). Another look at cue summation. *AV communication Review, 15*(4), 233-245.

Short, S. (1977). A Comparison of Variable Time-Compressed Speech and Normal Rate Speech Based on Time Spent and Performance in a Course Taught with Self-Instructional Methods. *British Journal of Educational Technology, 8*(2), 146-157.

Silverstone, D. M. (1974). Compressed speech. *audiovisual instruction, 19*(1), 42-43.

Sticht, T. G. (1969). Comprehension of repeated time-compressed recordings. *The Journal of Experimental Education, 37*(4).

Storck, J., & Sproull, l. (1995). Through a glass darkly: what do people learn in video conferences? *Human Communication Research, 22*, 197-219.

Tellis, g. j. (1997). Efective Frequency:one exposure or three factors? *Journal of advertising research, 37*(4), 75-80.

Voor, J. B., & Miller, J. M. (1965). The effect of practice upon the comprehension of time-compressed speech. *Speech Monographs, 32*, 452-455.

Williams, J. R. (1998). *Guidelines for the use of multimedia in instruction.* Paper presented at the Human Factors and Ergonomics Society 42nd Annual Meeting.

Zemlin, W. R., Daniloff, R. G., & Shriner, T. H. (1968). The difficulty of listening to time-compressed speech. *Journal of Speech and Hearing Research, 11*, 875-881.