EMOTIONAL AND COGNITIVE INTEREST: HOW CREATING SITUATIONAL INTEREST AFFECTS LEARNING WITH MULTIMEDIA

A Dissertation
Presented to
The Academic Faculty

by

Angela Yoo

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in the
School of Psychology

Georgia Institute of Technology
December 2016

EMOTIONAL AND COGNITIVE INTEREST: HOW CREATING SITUATIONAL INTEREST AFFECTS LEARNING WITH MULTIMEDIA

Approved by:

Dr. Richard Catrambone, Advisor
School of Psychology
Georgia Institute of Technology

Dr. Frank Durso
School of Psychology
Georgia Institute of Technology

Dr. Paul Verhaeghen
School of Psychology
Georgia Institute of Technology

Date Approved: December 8, 2016

ACKNOWLEDGEMENTS

Much gratitude is given to the members of my committee for their guidance, patience, and support. Also, the completion of this project would not have been possible without the help of my fellow psychology graduate students who were willing to share their logistical wisdom gained from experiencing this process before me.

TABLE OF CONTENTS

LIST OF FIGURES

SUMMARY

There is disagreement in scientific literature over the educational benefits of generating situational interest (Rey, 2012). Situational interest refers to the positive affect and sustained attention triggered by features of a particular context (Hidi & Renninger, 2006). Some studies show that interesting information can be highly motivating, thus enhancing learning. but other studies find it can hinder learning. There is some limited evidence that the seductive detail effect is due to additional cognitive load, disruption of meaningful information pathways, or the priming of inappropriate schema. Therefore, this effect may be weakened if the emotionally interesting information is relevant to the main idea. The findings from the following research show that irrelevant interesting material can produce the seductive detail effect only under certain conditions. No effects were found due to relevant and interesting details. Harp & Mayer (1997) had proposed that creating cognitive interest, rather than emotional interest, is a more effective strategy for engaging students and improving learning because the material can cue the relationships among concepts for easier processing. Hidi & Renninger (2006) argue that the distinction between emotional and cognitive dimensions is artificial and faulty. This research was able to replicate beneficial results from cognitive interest studies but did not find any evidence as to whether emotional and cognitive interests are the same or separate constructs. The problem was due to the operationalization of cognitive interest in previous studies, as well as the lack of validation for the strategies utilized to manipulate levels of cognitive interest.

Keywords: situational interest, cognitive interest, seductive detail effect

CHAPTER 1.   INTRODUCTION

Science, technology, engineering, and math (STEM) education has become a topic of much discussion and debate among educators, policy makers, and those in private STEM-related industries. A 2011 National Governors Association (NGA) report cited an increase of 12.4% for awarded STEM degrees in the U.S., compared to an increase of 35.5% for degrees in all disciplines, from 2000-2001 to 2008-2009. Furthermore, the United States' rate of postsecondary STEM-degree attainment is lagging behind Asian and European countries. This slow growth in U.S. educational attainment has been outpaced by the demands for qualified workers in STEM career fields. One of the systemic issues identified as a contributing factor to this STEM problem by the NGA report is a "failure to motivate student interest in math and sciences." The report faults an educational system that relies on the instruction of these subjects as discrete topics and that ignores the student's need for relevance and real-world connections. The recommended solution is to motivate interest using teaching strategies that employ realistic applications of STEM concepts.

The idea of creating an interesting experience to enhance the effectiveness of learning is again at the forefront of another popular current topic in education – the Massive Open Online Course (MOOC). Because of the poor completion rates, with many below 5%, MOOCs have become an appropriate platform for investigating the content and structure of instruction, particularly online instruction, that motivate and engage students (Educause, 2013). The mission statement for one of the leading MOOC providers, Udacity, embraces a belief in "bring[ing] accessible, affordable, engaging, and highly effective

higher education to the world" ("About us," n.d., para. 1). A study by Sun and Rueda (2012) on computer self-efficacy, engagement and online distance education echoes these sentiments for creating interesting experiences in online learning environments. Use of multimedia activities and tools can increase the level of interest demonstrated by a student taking an online course, and this level of interest significantly correlates with emotional engagement.

Although creating an interesting experience for learners is a laudable goal, there are inherent challenges in developing course content that is both "engaging" and "highly effective." One of Udacity's instructors Don Norman (2013), author of The Design of Everyday Things, speaks of the difficulty of accomplishing this task. He is currently creating a MOOC on industrial design that uses a more stylized and produced live-action video format similar to standard educational videos rather than the traditional online lectures of a "talking head" or a "talking hand." The purpose of this new format is to provide a more exciting and appealing version of the online video lecture components. However, the developers are struggling with how to ensure that learning objectives are clear and that the interesting features are not detracting from the primary purpose of the video.

1.1   Interest Learning Theory

This challenge of mediating a desire for interest and engagement with the need to produce effective learning outcomes is mirrored in the work of educational and cognitive psychologists, with researchers finding contradictory or mixed results for increasing interest levels in students (Rey, 2012). Interest-oriented learning research began in the early twentieth century but became neglected with the onset of behaviorism (Schiefele, 1991).

After a wave of studies on intrinsic motivation in the 1980's, a resurgence of research on the role of interest in learning emerged. These researchers argued that the concept of motivation fails to address important aspects of how a person learns, particularly how a person becomes motivated or develops intrinsic motivation in order to want to learn (Krapp, 1999). They considered interest to be a distinct and separable phenomenon from motivation for the following reasons:

- Interest is content-specific, unlike motivation, which would describe a general predilection to put forth effort into any task (Hidi & Renninger, 2006; Schiefele, 1991).

- Interest explains why a person chooses which topic or area to which he or she seeks further exposure and for which he or she exerts more effort (Schiefele, 1991).

- Interest can be specific to a context, a time period, or an activity. It can be triggered by those external factors, rather than always being inherent to a person (Schiefele, 1991).

- The concept of interest supplements other theories of knowledge acquisition that predict a person's tendency to learn new information in particular domains (Schiefele, 1991).

- There is more potential for influencing content-specific interest through instructional design than for changing a person's motivation orientation (Schiefele, 1991).

- There is an interplay of both affect and cognition with interest (Hidi & Renninger, 2006). In contrast, a highly motivated person does not

necessarily find enjoyment or positive affect in his or her fields of
achievement or expertise.

- Both the affective and cognitive components of interest could have
biological roots (Hidi & Renninger, 2006).

A learner's level of interest can impact learning. In several studies by Schiefele
(1991), readers of a high-interest text, compared to readers of a low-interest text, were able
to answer more comprehension questions correctly, recall more main ideas, and recall ideas
more completely. Schiefele (1991) suggested that the greater amount of interest and
enjoyment led to deeper processing and enhanced understanding of the material. This, in
turn, resulted in higher measures for learning.

1.1.1 Types of Interest

Interest can be categorized into three categories: individual, situational, and topic
(Ainley, Hidi, & Berndorff, 2002). Individual, or personal interest, describes a more stable
characteristic of a person that depends on the person's personality and prior knowledge and
experience (Ainley et al., 2002; Krapp, 1991; Schraw, Bruning, & Svoboda, 1995). This
category of interest predicts how likely a particular individual is to attend to specific stimuli
and is demonstrated through positive affect, a consistent desire to repeatedly engage with
the content, and self-directed activities (Ainley et al, 2002). Essentially, the individual can
create a positive feedback loop in which exposure to new information increases interest
and a desire to acquire more information. Individual interest, being a personal attribute, is
more similar to intrinsic motivation than the other two categories of interest, and the focus

of this research is to examine manipulations of learning material. Therefore, individual interest is not considered in this study.

Situational and topic interests involve attributes of a particular environment or context, rather than solely that of a person (Ainley et al., 2002). Situational interest refers more to environmental stimuli and the general structural features of a situation (Ainley et al., 2002; Schraw et al., 1995). This can include organization and order of presentation of information, unexpectedness or irony, text cohesion, use of concrete ideas and images, universal life themes, intensity of triggered emotions, or ambiguity. Because the specific context has the potential to change rather quickly, situational interest is briefer in duration than the other forms of interest. In contrast, topic interest concerns the specific subject presented and emerges as an interaction between situational and individual factors. Because topic interest involves characteristics of an individual, this construct also is not included in this research.

There are several additional reasons why situational interest is the concept of focus. First, the problems introduced by concerns with STEM education in the U.S. and MOOCs have led those involved in these areas to encourage alternative pedagogical strategies and educational material that increase the situational interest of learning content. Secondly, the first two phases in Hidi's and Renninger's (2006) proposed model of interest development require an incitement and then maintenance of situational interest. Expressly, more enduring, well-developed types of interest (i.e. individual interest) cannot form unless situational interest has been established for a person. Situational interest is necessary to drive behavior, in which the person seeks continual opportunities to learn about a subject (Hidi & Renninger, 2006). This continual learning leads to individual interest. Lastly, the

body of work is relatively sparse around the validity of situational interest. Not only is the work lacking, but the research regarding situational interest has also been ambiguous, with an opposing stance to interest learning based on what has been termed "seductive details," which will be discussed in a later section (Rey, 2012).

1.1.2   Empirical Findings

There is existing empirical support from psychologists for interest learning theory – the idea that the more interesting the material is, the more likely a student is to learn and remember the material (Ainley et al., 2002; Schiefele, 1991; Schraw et al., 1995). This is especially true when measuring elaborative processing and comprehension, rather than simple recall or recognition (Schiefele, 1991). Ainley et al. (2002) found data that would suggest a model to explain this process. In a study involving order choice of several texts on various topics, there were statistically significant correlations between interest and text order choice, interest and positive affect regarding the text, affect and time spent reading, and ultimately between persistence and test scores on comprehension and recall. This would imply that students' interests and enjoyment led to more time and effort spent on a text, enabling them to learn more effectively. Likewise, benefits from situational interest have been found with multimedia learning with information related through narration (Park, Moreno, Seufert, & Brünken, 2011).

1.2   Seductive Details

However, not all the research supports interest-based learning. Garner, Alexander, Gillingham, Kulikowich, and Brown (1991) found that efforts to artificially induce interest, particularly with extraneous details, divert the learner's attention and reduce the ability to

recall relevant information. They termed these interesting but distracting details "seductive." These seductive details from a text were highly memorable to the undergraduate participants on tests of learning compared to details that were of high importance but of low interest. In a study by Harp and Mayer (1997), students, when provided reading material that had interesting but irrelevant text and illustrations, were able to recall less information and generate fewer novel solutions on transfer tests compared to students given the control text without the interesting material. Similar findings resulted from a study by Harp and Maslich (2005) examining the distracting effect of seductive details in classroom lectures, which demonstrated that seductive details can impact lecture-based learning in addition to text-based learning.

1.2.1   *Effects on Learning Processes*

Several possible hypotheses based on cognitive principles have been proposed to explain the seductive detail effect (Harp & Mayer, 1998). According to cognitive load theory and the distraction hypothesis, seductive details can create greater cognitive load, which leads to the learner attending to only some of the learning material, usually the interesting details rather than the most germane details (Harp & Mayer, 1998; Mayer, Griffith, Jurkowitz, Rothman, 2008; Rey 2012). Another possibility is stated by the disruption hypothesis, which is the notion that these details interrupt the flow of ideas in the learning material and inhibit the learner's ability to coherently organize and relate the main ideas into causal pathways (Harp & Mayer, 1998). However, in a series of four experiments by Harp and Mayer (1998), the researchers found more evidence supporting a third hypothesis, the diversion hypothesis, which suggests that the seductive details inappropriately prime schema that are not relevant for the task at hand. Experimental

manipulations attempting to focus the students on a passage's most critical ideas and cuing students to the relevant steps of the process described had no significant interactive effects with the seductive details. In other words, these interventions did not mitigate the effects of the seductive details, and the results, therefore, possibly indicate that the problem does not lie in the distraction of the learner's attention or the disruption of logic pathways for the main concept. Instead, placing seductive details before main ideas significantly prevented learning compared to placing the seductive details after the main ideas. The resulting mental models created by the learners would then be based on the information emphasized by the seductive details, rather than being organized around the most important principles (Harp & Mayer, 1998).

In 2007, Lehman, Schraw, McCrudden, and Hartley refined the Harp and Mayer studies and found evidence supporting all three hypotheses. Participants in the study spent less time reading the important details, recalled fewer of those details, and demonstrated less holistic understanding of the material if there were seductive details included. These results show that learners' attention can be distracted from the critical ideas in text, delegating less time to those sections, and also that the seductive details disrupt the formation of coherent, holistic ideas.

The study by Sun and Rueda (2012) with online distance learners finding higher emotional engagement with interesting instructional design elements also found nonsignificant correlations with behavioral and cognitive engagement. The learners did not put forth more effort to use particular learning strategies or spend more time using the instructional material even with a greater number of interesting details. There is even more evidence for this seductive detail effect in a review of the literature (Rey, 2012). In a meta-

analysis of findings on seductive details, nearly two-thirds of the studies included in the analysis supported fully or partially the detrimental effects of seductive details. The data in aggregate appear to demonstrate up to a small to medium effect size (d = 0.3) for the reduction in recall and a medium effect size (d = 0.48) for transfer of knowledge tasks.

1.2.2   Mixed Findings

The results on the seductive detail effect come with a caveat. Rey (2012) cautions that the effect sizes for the seductive detail effect could be somewhat biased or inflated due to the inclusion of only journal articles for the meta-analysis, as well as the lack of studies with nonsignificant results being published. Additionally, the experiments with mixed or negative results for the seductive detail effect show that particular types of interesting detail, the learning domain, time limits, and amount of cognitive load can temper the inhibitive or distracting effects of seductive details (Rey 2012). One example of how mitigating factors can result in mixed data comes from the study by Garner et al. (1991). Researchers had rated details on a scale of interestingness and relevance and found that details that were moderately relevant and moderately interesting were recalled more frequently by participants. Although the most important details, which were rated as uninteresting, were not remembered as well, the finding that some of the germane details could be recalled if considered interesting gives interest learning theory some merit. Therefore, developing interesting text should not be a function of inserting additional information that generates interest outside of the main idea but rather a function of making a specific concept inherently interesting. Rey (2012) in his meta-analysis also suggests that the relevance of an interesting detail to the main idea can reduce the distracting effect of

seductive details. If the interesting concepts are closely aligned to the main ideas, there should not be any interference with cognitive processes.

Indications that relevance is the key difference in determining whether details enhance or prevent learning can be found in studies considering illustrations that accompany text. In the case of reading text, purely decorative illustrations do not benefit the understanding of the content of the text, but illustrations that depict the information, help to organize or interpret the information, or provide memory devices for learning the information can moderately benefit the retention of that information (Carney & Levin, 2002). Any lack of enhanced learning with purely decorative images could possibly be moderated but other variables, such as prior knowledge of the learner (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014). In a study involving geometry students, decorative illustrations that incited situational interest were distracting for learners with little prior knowledge, but actually served to motivate and enhance learning for learner with more prior exposure to the topic.

1.3   Cognitive Interest

Instead of adding emotional interest with seductive details, Harp and Mayer (1997) suggest using cognitive interest as an alternative way to enhance learning. Harp and Mayer argue that seductive details are based on emotional interest. These extraneous details incite stronger emotions to encourage greater attentiveness to those details, but they do little to help the learner process the important main ideas more efficiently. Instead of relying on seductive information, design of learning materials should rely on strategies that increase cognitive interest in the primary principles. To generate cognitive interest, topics should be presented in a way that the learner finds easier to comprehend and process for learning

because the presentation signals the underlying structure of relationships of relevant concepts. Such strategies would include identifying main ideas, relating information to appropriate prior knowledge, and linking related topics. The idea is that, if topics are presented in a way that learners find easier to understand, the topics will seem more interesting. When comparing performance on both recall and problem-solving transfer in the 1997 Harp and Mayer study, students scored higher marks if using text and illustrations that helped to organize and explain a topic (i.e. cognitively interesting details) than if the text and illustrations included extraneous, irrelevant content (i.e. seductive details).

Furthermore, the distinction made by Harp and Mayer (1997) between cognitive and emotional interest could be supported possibly by findings in the study on seductive details and graphic organizers by Rowland-Bryant (2010). Graphic organizers help learners connect ideas to form relationships among concepts through visual representations. This is similar to the function of features of text that provide cognitive interest. In Rowland-Bryant's study (2010), the use of graphic organizers lessened, but did not overcome the distracting effect of seductive details.

Another criticism with cognitive interest comes from a neuroscientific perspective, according to Hidi and Renninger (2006). They argue that separating affective from cognitive processes and, therefore, emotional from cognitive interest is arguably an artificial distinction because of the function of the lateral hypothalamus. The lateral hypothalamus plays a major role in seeking behavior and is responsible for inducing feelings of interest and curiosity (Panksepp, 1998). According to Hidi and Renninger (2006), regardless of the type of stimulus that triggers an interest response or regardless of whether the person is cognitively processing or affectively responding to the stimulus, the

11

lateral hypothalamus is activated in the brain. However, the lateral hypothalamus is active in generating repeated behavior, but only for conditioned responses, not necessarily for more complex learning (Panksepp, 1998). Panksepp argues that cognitive and affective phenomena are distinct, and his article cited by Hidi and Renninger (2006) even states that "if we conflate emotions and cognitions too much in our thinking…we may retard a fundamental understanding of affective processes and thereby, a real understanding of how cognitive activities are modified by emotional states" (Panksepp, 2003, p. 5).

1.4   Current Investigation

Much of the research on interest learning theory and the seductive detail effect have involved learning from text. There have also been studies involving illustrations, lectures, background music, and multimedia (Rey, 2012). The present study focused on multimedia, specifically educational videos, to be more directly applicable and relevant to the growing use of technology in the classroom with MOOCs and other online formats. Participants in all conditions watched a video on human digestion. The experiment was a 3 x 2 factorial design with six videos total – one created for each condition. Two preliminary studies were conducted to develop the scripts for the videos.

1.4.1   Relevance of Interesting Details

The purpose of the main study was twofold: to explore the mitigation of the seductive detail effect through increased relevance of interesting details to main ideas and to examine the distinction between cognitive and emotional interest. The relevance of interesting details to a main idea and the effect of that interesting material on learning was the primary focus of this research. How performance on shallow processing (recall and

recognition) and deeper processing (transfer) tests can be impacted by interesting information was examined also.

Many of the previous studies have measured learning by using free recall only after learners had been exposed to the learning material (Garner et al, 1991; Harp & Maslich, 2005; Harp & Mayer, 1997; Harp & Mayer, 1998; Lehman & Schraw, 2002; Lehman et al., 2007; Mayer et al., 2008; Park et al., 2011; Ozdemir, 2009; Schiefele, 1991; Schraw et al., 1995). Rey (2012) has suggested that part of the reason that there are mixed findings on situational interest and the seductive detail effect was due to the different types of measures used to gauge learning. Similar to previous studies, shallow processing was measured with free recall after participants have viewed the learning material for the current study. However, free recall after exposure to the material did not account for prior knowledge sufficiently or for variables that could cause free response differences, such as writing abilities or motivation to write large amounts of text (Schiefele, 1991).

Due to the possibility that free recall alone could be an insufficient measure for shallow processing, a post-test score also measured learning. A pretest score was used to explore the possibility of prior knowledge as a covariate for the experimental groups. Both the pre- and post-test consisted of multiple choice, fill-in-the-blank, and short answer questions but the questions were different for the two forms. Some of the questions assessed shallow processing by asking students to simply identify a concept through recall or recognition while other questions measured deep processing by requiring students to explain causal relationships and make inferences. Again, the variety of questions used to evaluate deep processing, or transfer, were used to overcome any potential issues with using only free response or essay questions, which were typical of previous studies (Garner

13

et al, 1991; Harp & Maslich, 2005; Harp & Mayer, 1997; Harp & Mayer, 1998; Lehman & Schraw, 2002; Lehman et al., 2007; Mayer et al., 2008; Park et al., 2011; Ozdemir, 2009; Schiefele, 1991; Schraw et al., 1995). Only full credit for completely correct answers was awarded, and an overall score was recorded, along with separate scores for correct responses to shallow processing questions and deep processing questions.

Another advantage of having directed questions instead of free response essays was that these questions could demonstrate whether the effects of adding situational interest were localized to specific details or generalized to the whole video. According to interest learning theorists, some of the positive benefits that arise from creating situational interest is greater sustained attention and improved motivation to engage with the learning material (Ainley et al, 2002; Hidi & Renninger, 2006; Sun & Rueda, 2012). To examine whether the increased attention could be generalized to the main subject of the learning material, some of the questions, referred to as "global" questions, on the post-test concerned subject matter not contained in the manipulated sections in the seductive detail or relevant interest conditions. Other questions, referred to as "local" questions, on the post-test concerned the subtopics that are addressed by the interesting statements in the seductive detail or relevant interest conditions. For learners in any of the high interest conditions, correct responses primarily for local questions would have provided evidence that interest incites focused, localized attention. Correct responses for both global and local questions would have indicated that interest produces a broader effect on attending to learning material. In the case that the correct responses were for only global questions, this would have been possible evidence for distractions, though very brief and short-lived distractions, from only the parts of the material that incite emotional interest.

By creating situational interest with statements that were emotionally engaging but less similar to the main idea of the instructional video, the study was expected to replicate the findings of Garner et al. (1991) and other seductive detail effect researchers (Harp & Mayer, 1997; Mayer et al., 2008; Rey, 2012). However, performance was predicted to improve with emotionally interesting details if relevance of the detail to the content of the videos was controlled. When the interesting details did not contain additional information, but instead contained similar information as the main idea, the distracting effect seen with seductive details was not expected to be found. Thus, instructional material with interesting details should have improved learning outcomes for both shallow and deep processing compared to instructional material that contained no interesting details. Such results would have supported the hypothesis that developing situational interest to enhance learning was not a matter of adding extraneous information that compromised the coherence of the learning material but an act of attempting to present information in an inherently interesting manner. If there was strong relatedness in the interesting details with the original principle ideas, there should have been a benefit to learning outcomes in a more global, generalized way with attention extended to other parts of the learning material.

1.4.2   Relevance of Interesting Details

The second aim of this research was to examine whether emotional interest and cognitive interest are separate constructs. The distinction between cognitive and emotional aspects contradicts the definition of interest, which necessitates both affective and cognitive changes. Therefore, the phrase "cognitive interest" is used in the remainder of this document to refer to interest incited by strategies used by Harp and Mayer (1997) emphasizing the cognitive processes of interest, and "emotional interest" will refer to

15

strategies emphasizing affective processes, as exemplified by most interest learning researchers, such as Schiefele (1991). The use of "cognitive interest" and "emotional interest" does not indicate necessarily a true differentiation between the cognitive and emotional processes of interest.

For the possibility to remain that emotional interest and cognitive interest are indeed the same phenomenon, as proposed by Hidi and Renninger (2006), there should not have been any interactive effects in the data for emotional interest-only conditions and cognitive interest-only conditions. Lack of interaction, however, would not necessarily indicate that cognitive and emotional interests are undeniably the same, but the hypothesis that they are the same would remain tenable. Conclusively determining synonymity or a dichotomoy would not have been possible from nonsignificant results for the interaction. On the other hand, the presence of any significant interactions possibly could have suggested they are indeed different phenomena. Due to the evidence from Harp and Mayer (1997), learning outcomes were expected to demonstrate an interactive effect. In other words, learning was predicted to improve with more cognitive interest compared to conditions with low interest material or material with seductive details by increasing the efficiency of processing the material. However, when there was emotionally interesting material that was also relevant to the learning material, adding cognitive interest should not have had any additional benefits than what was already provided by the emotionally interesting and relevant details.

CHAPTER 2.   MATERIALS DEVELOPMENT

There were three experiments performed for this study. The purpose of the first two experiments was to determine what would be appropriate content for each video script for the different conditions in the third main experiment. The first experiment measured relative interestingness of sets of three sample texts while the second asked participants to rate similarity of two text samples compared to a third. The text samples then were designated as control, relevant interest, or irrelevant interest (seductive details) content based on the results of these two surveys.

2.1   Experiment 1

Online surveys were used to determine what types of information would be considered more interesting by participants.

2.1.1   Participants

Adult users of Amazon Mechanical Turk (MTurk) and undergraduates in psychology courses at Georgia Institute of Technology (GT) completed the surveys for the material development stage of this research. Both populations were included to ensure that the results of the survey reflect interests of a general population, rather a specific specialized population, such as university students.

There were 20 students and 20 MTurk users who answered the survey. GT students were recruited through the university's web-based research subject management software and were awarded course credit for their participation. Only students who are considered adults according to institutional policies were eligible for the experiment. Amazon

Mechanical Turk was the online system used for recruiting English-speaking adults from the general population. MTurk users were compensated $2 for completing a survey and were allowed to complete only one survey.

2.1.2 Materials

Both MTurk and undergraduate student participants completed surveys consisting of 20 sets of three sample texts (Appendix A). The sets, as well as the order of the sample texts within each item, were presented in random order to each participant. The texts cover information about human digestion. The content was derived from a number of sources, including anatomy and physiology textbooks, other science books, podcasts, and a variety of health, science education, and encyclopedia websites.

2.1.3 Procedure

All surveys were administered online through MTurk and SONA. Participants ranked sets of three short passages based on how interesting they found the content. The passages deemed least interesting were used in the control script in Experiment 3. Additionally, participants gave an absolute interestingness score based on a 7-point Likert-type scale used by Mayer, Griffith, Jurkowitz, and Rothman (2008) and Ozdemir (2009).

2.1.4 Data Analysis

Results of each item on the survey were analyzed with a Friedman Test for repeated measures and was considered statistically significant at an α level of 0.05. Sample text sets #3 ($\chi2 = 11.84$, $p < 0.01$), #4 ($\chi2 = 20.05$, $p < 0.01$), #6 ($\chi2 = 17.53$, $p < 0.01$), #7 ($\chi2 = 47.53$, $p < 0.0$), #8 ($\chi2 = 10.38$, $p = 0.01$), #10 ($\chi2 = 26.00$, $p < 0.01$), #14 ($\chi2 = 10.76$, $p =$

0.01), #16 ($\chi 2 = 7.51$, $p = 0.02$), #17 ($\chi 2 = 22.76$, $p < 0.01$), # 18 ($\chi 2 = 24.49$, $p < 0.01$) #19 ($\chi 2 = 19.68$, $p < 0.01$) were found to be statistically significant. For these sets, the sample texts significantly differed from each other in their ranking according to interest. Pairwise comparisons were made for each set using the Wilcoxon Signed Ranks Test to determine which of the sample texts would be used in the control conditions. The results of these tests were considered significant at a corrected α level of 0.017.

2.2   Experiment 2

Online surveys were used to determine which texts would be considered more similar by participants.

2.2.1   *Participants*

As in Experiment 1, both adult users of Amazon Mechanical Turk (MTurk) and undergraduates in psychology courses at Georgia Institute of Technology completed the surveys on similarity and relevance. Ten MTurk and 10 undergraduates completed the surveys.

As in the first experiment, the same recruitment methods were employed, but they were not eligible for participation if they had completed a survey for Experiment 1. Compensation was halved to $1 per survey for MTurk users due to the shorter length of the survey.

2.2.2   *Materials*

The surveys consisted of the 11 sets of sample texts with significantly different interest rankings from the first experiment (Appendix B). The sets were presented in random order for each participant.

2.2.3 Procedure

All surveys were administered online through MTurk and SONA. For each item, participants were presented with the sample text rated as least interesting in Experiment 1. Two other sample texts appeared in random order below the first control text. Participants ranked one of the two texts as more similar and relevant in meaning to the first control text.

2.2.4 Data Analysis

Results of each item on the survey were analyzed with a Chi-squared test of proportions and were considered statistically significant at an α level of 0.05. Sample text sets (Appendix B) #1 ($\chi2 = 8.00$, $p = 0.005$), #2 ($\chi2 = 11.84$, $p < 0.01$), #4 ($\chi2 = 4.26$, $p = 0.04$), #5 ($\chi2 = 15.21$, $p < 0.01$), #6 ($\chi2 = 4.26$, $p = 0.04$), #9 ($\chi2 = 15.21$, $p < 0.01$), and #11 ($\chi2 = 11.84$, $p < 0.01$) had answer choices with significantly different ratings of similarity of meaning when compared to the given control text. The more relevant text samples were used in the relevant emotional interest conditions while the less relevant texts were used in the seductive detail conditions.

CHAPTER 3.   METHODS FOR EXPERIMENT 3

The final experiment tested for any difference in learning outcomes among the three conditions: control, relevant interest, and seductive details. This experiment also attempted to define cognitive interest as a distinct construct from emotional interest.

3.1   Participants

The participants were 93 undergraduates enrolled in introductory psychology courses at Georgia Institute of Technology. Students were randomly assigned to each of the six conditions, with 16 students in each of the conditions without cognitive interest and 15 students in the conditions with cognitive interest. The SONA recruitment system was the primary means of recruitment although some were recruited through brief classroom presentations, flyers, and word of mouth. Most students received points for class credits through the SONA system, but there were two students who voluntarily donated their time. Only students legally considered adults according to institutional policy and who were capable of viewing audiovisual media and reading and writing English were eligible for the experiment. Otherwise, there were no other disqualifying demographic factors.

3.2   Materials

Prior to beginning a session, every participant completed an informed consent form. During the course of an experimental session, they also completed a preliminary questionnaire and an exit questionnaire (Appendix D). The first questionnaire given before the video viewing contained basic demographic questions, Likert-type items regarding

interest levels on science, biology, and anatomy, and a prior knowledge assessment. The exit questionnaire was divided into two sections. The first section contained the same Likert-type items as the preliminary questionnaire, in addition to a free response prompt. The final section contained test questions on the content of the learning material. Thirteen of the questions measured shallow processing while the remaining questions involved deeper processing. Shallow processing questions required the participants to recall or recognize facts from the videos. An example of a shallow processing question was:

> The large intestine contains many _____ ,
>
> which contribute to the fermentation process.

This question required participants to identify the location and role of bacteria or microorganisms in the gut. Deeper processing questions required participants to make inferences based on the presented information or to connect concepts in the video. An example of a deeper processing question was:

> We know that the digestive process is _____ because
>
> of the indigestible material that is eliminated from the body as feces. Circle
>
> one answer.
>
> a. inefficient   c. efficient
>
> b. combustible   d. incombustible

The questions required the participant to induce that the production of waste materials is evidence of an inefficient digestive system.

Interesting material in the experimental video conditions occurred in seven different sections, and there were two questions for each of these seven sections to produce

a local learning score. Additionally, there were 11 questions regarding topics other than the ones addressed by the interesting material, and the score for these questions were considered a global learning score. The tests were piloted with graduate students to determine validity and appropriate levels of difficulty for the items.

Videos involving screen capture and narration were used in each of the six conditions. The types of illustrations that were used in the screen capture for all conditions were representational picture. Representational pictures are those that simply depict the concepts being described in the audio but do not provide any type of organizational support for the concepts (Carney & Levin, 2002). Three of the videos did not include any features that would add cognitive interest and only manipulated the amount and relevance of emotional interest. The first of these three videos for the no cognitive interest conditions contained only basic facts about human digestion and served as the control. In the highly relevant emotional interest condition, the video contained narrative that supplemented the information in the basic control video with facts that have been rated as more interesting and more relevant to the main ideas. The second video for the irrelevant emotional interest condition – or the seductive detail condition – included anecdotes and facts that had been rated as less relevant to the video's main ideas.

A second set of three videos used the same scripts as the previous set of three videos for the emotional interest conditions but also included an explanative summary at the end of six sections within the video to provide cognitive interest. Explanative summaries were used in the study by Harp and Mayer (1997) to create cognitive interest, and these explanative summaries highlighted major components of the system, important steps involving these components, and some of the causal processes that occur. Because all the

information was presented aurally, the explanative summaries were also presented through narration. The videos ranged in length from approximately 11.5 minutes to approximately 12 minutes.

Some of the content of the video scripts was determined by the results from the first two experiments. In order for a text to be included in the control script, a statistically significant proportion of participants must have rated the text as least interesting out of three sample texts presented in Experiment 1. An example of a control passage was:

> The large intestine primarily serves as a site for fermentation of indigestible matter by gut bacteria and for reabsorption of water before excretion. Flatulence-inducing hydrogen gas and sometimes methane are byproducts of this process. Some vitamins, such as biotin and vitamin K produced by bacteria in the colon are also absorbed into the blood in the colon.

An example of the substituted passage with seductive details was:

> The large intestine serves as a site for fermentation of indigestible matter by bacteria and for reabsorption of water, vitamins, and minerals before excretion. Scientists are discovering how important microorganisms in the large intestine are for healthy digestion. The typical human digestive tract contains about 2,000 species of bacteria, fungi, and protozoa.

In the above passage, the seductive details elicited an emotional response from the learner through surprising facts that he or she might even find distasteful. However, knowing the number of species that exist in the human gut is not essential to knowing about the functions of those microorganisms. An example of the passage with relevant emotional interest was:

24

The large intestine is responsible for generating new epithelial cells and provides protective mucus and mucosal immunity. The large intestine contains microorganisms that are responsible for fermentation of indigestible matter and that produce vitamins that are absorbed by the large intestine. The importance of these microorganisms is highlighted by the fact that a person will carry approximately 3 pounds and 100 trillion bacteria in his or her digestive tract.

Although the above passage could produce a similar emotional response as the seductive detail passage, knowing the weight of gut bacteria would have more relevance by highlighting the importance of bacterial functions, as indicated by the amount of bacteria.

3.3   Site of Study and Procedure

All sessions were conducted in the Problem Solving and Educational Technology Lab at Georgia Institute of Technology. Upon signing the consent form and completing the preliminary questionnaire, participants were randomly assigned to watch one of the following videos:

a)   the control with low emotional and low cognitive interest

b)   seductive detail condition with low relevance, high emotional and low cognitive interest

c)   high relevant interest with low cognitive and high emotional interest

d)   high cognitive interest and low emotional interest

e)   seductive details with low relevance, high emotional and high cognitive interest

f)   high relevant interest with high emotional and high cognitive

interest

After viewing the videos, the participants then answered the post-test questions. One hour-long session was required per participant.

3.4   Scoring Scheme

Learning outcomes were measured by a free recall exercise and by scores based on the number of correctly answered items on the second section of the exit questionnaire. For the free recall assessment, each concept from the video was awarded a point for complete and correct statements and 0.5 points for a partially correct or partially complete statement. The free recall assessments were scored by the researcher and a second grader. The interrater reliability for the scores was calculated to be $\alpha = 0.96$.

For the pre- and post-tests, each correctly answered item was given a score of 1 point. Answers must be completely correct, and no partial points were awarded. Additionally, on the post-test, the points were totaled separately for the shallow processing questions and the deep processing questions for each participant. Similarly, the points for the local item questions were summed separately from the global item questions. Local test items concerned content that was manipulated in the experimental conditions. The global questions concerned topics from parts of the video that were not manipulated for the experimental conditions.

CHAPTER 4. RESULTS AND DISCUSSION

For each condition, the following mean scores were calculated: free recall score, total post-test score, shallow processing, deep processing, local, and global. The means among the experimental groups were considered to be statistically different at a significance level of $\alpha = 0.05$.

For the free recall exercise, two graders scored the responses, and Crohnbach's α for interrater reliability was calculated to be 0.96. SAT math scores ($F = 5.92$, $p = 0.02$), pre-test scores ($F = 8.54$, $p = 0.01$), and interest levels in biology ($F = 7.13$, $p = 0.01$) were found to covary significantly with the free recall scores. Pre-test scores ($F = 10.66$, $p < 0.01$) and interest in biology ($F = 7.87$, $p = 0.01$) also significantly covaried with the overall post-test scores.

Biology interest level and pre-test scores were indicators of prior knowledge or exposure to topics on digestion, and their role as covariates was expected. What is somewhat unexpected is the SAT math score covariate and the absence of interest in digestive anatomy and interest in health and diet as covariates. For the SAT math score, one possible explanation could be that the math score was a better measure of general intellectual ability and motivation for this particular group of participants, which included international students and non-native English speakers. Variations in verbal scores might have been more reflective of native language, rather than the ability to learn and the motivation to perform well. Both the amount of processing and the amount of writing is greater for the free recall exercise than for the post-test, which would be a reason why the SAT math score covariate appears only for the recall scores but not for post-test scores.

For interest levels in anatomy and health, perhaps the domains are so narrow that they do not expose those interested to a broad enough range of information. For example, someone interested in health could focus on fitness or nutrition topics but would not necessarily be exposed to information on physiology and biochemistry. In contrast, someone with interest in biology potentially could be familiar with a wide variety of topics that include the subjects that were part of this research. Without additional explorations, making any conclusions about the covariates would be difficult.

4.1 Seductive Details and Cognitive Interest

Once the indicated covariates were considered, main effects for both cognitive (F = 4.65, p = 0.04) and emotional (F = 9.32, p < 0.01) interest were found for the free recall exerciseFigure 2 – Effects of the relevance of interest on free recall scores.. A significant main effect for only cognitive interest (F = 4.44, p = 0.04) resulted for the post-test scores. Interactions were not significant for either the free recall scores (F = 0.65, p = 0.53) or overall post-test scores (F = 0.30, p = 0.74). No effects for sub-score measures (shallow processing, deep processing, localized effects, and global effects) were statistically significant.

4.1.1 Effects of Adding Cognitive Interest

The results replicate the findings on cognitive interest of Harp and Mayer's 1997 study. Compared to the conditions without cognitive interest, participants learning from the high cognitive interest materials had higher free recall (M = 8.52, SD = 4.82) and overall post-test scores (M = 59.02, SD = 16.95) when compared to free recall scores (M

= 6.84, SD = 3.40) and overall post-test scores (M = 55.83, SD = 17.66) of those in the

control condition (Figure 1).
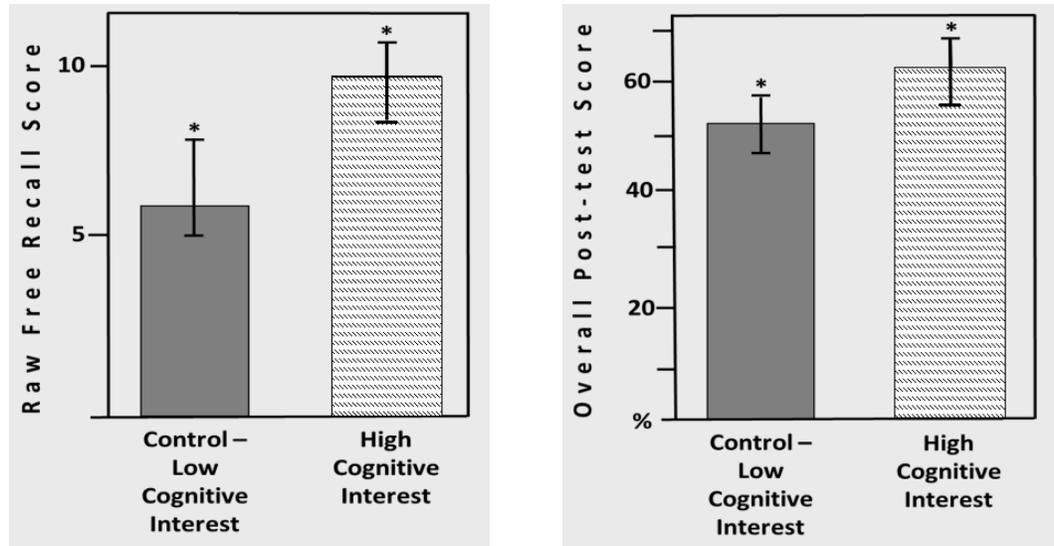
Figure 1 – Effects on free recall scores and post-test scores from adding explanative summaries for cognitive interest.

Such results support the idea that material that is easier to process for learning also provides some level of situational interest that contributes to improved learning. One possible problem with this interpretation, however, is that adding explanative summaries to create cognitive interest consequently added a second opportunity to hear the information that was being presented in the videos. Repeated exposure to learning material can improve performance on immediate recall (Tulving, 1967). Further studies investigating whether the improvement in learning can be attributed to the frequency of exposure or to the cognitive interest that arises from the clarity of organization and concepts is necessary.

4.1.2   Effects of the Relevance of Learning Materials

The results for emotional interest and the relevance of emotionally interesting details were more mixed. Pairwise comparisons with Sidak-adjusted p values were statistically significant when comparing results between the control groups and the seductive detail group (t = 2.80, p = 0.02) for the free recall scores (Figure 2).
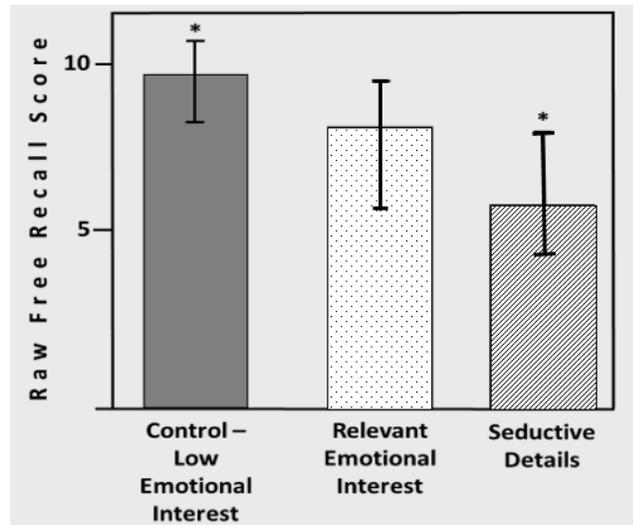
Figure 2 – Effects of the relevance of interest on free recall scores.

The control group's scores (M = 8.10, SD = 5.38) were greater on average than the scores for the seductive detail condition (M = 7.00, SD = 3.77). This result lends additional support to the seductive detail findings of Garner et al. (1991), Harp and Mayer (2006), and Mayer et al. (2008). Details in learning material that are not relevant to the main learning object appear to be harmful for learning when learning is measured by the ability to recall information. However, there were no other significant differences (t = 2.00, p = 0.15) between the control and the relevant interest groups (M = 7.85, SD = 3.24) or between the seductive detail and relevant interest groups (t = 2.00, p = 0.74). These results appear to suggest that, while relevant emotional interest can compensate for any distracting aspects

of seductive details, the amount of interest generated in the relevant emotional interest condition is not enough to be advantageous compared to low-interest learning material.

Perhaps any effects of including such emotionally interesting information would have impacted affective states more so than cognitive processes. Further work using a variety of strategies to measure affect and cognition is necessary to determine what effects these details have if there are any at all. Part of the difficulty is finding material that is sufficiently interesting and interesting to enough people. When comparing the Likert-type ratings for how interesting participants found the text samples in Experiment 1, many of the differences among the ratings were not significant. Ranking the text samples according to interest forced the participants to make relative judgements about how interesting the texts were, but the ratings, which allowed participants to assign the same level of interest to each of the texts, were not always statistically different. Although having a method of systematically verifying that a piece of information will be considered interesting is important, the issues seen with the particular process used for this experiment underline the inherent challenge of establishing what is interesting to a general audience.

As predicted, the format of assessment appears to affect the measure of learning outcomes. Recall assessments tend to be more difficult, require more information to be encoded, and produce worse scores compared to assessments that rely on recognition tasks (Tversky, 1973). Because the post-test questions relied on a combination of both recall and recognition items, the detrimental effects of seductive details were no longer observed. No discernible effects ($F = 0.667$, $p = 0.65$) were found for overall post-test scores across the control (M = 56.77, SD = 19.33), relevant interest (M = 58.45, SD = 14.78), and seductive detail (M = 56.90, SD = 18.00) conditions (Figure 3).
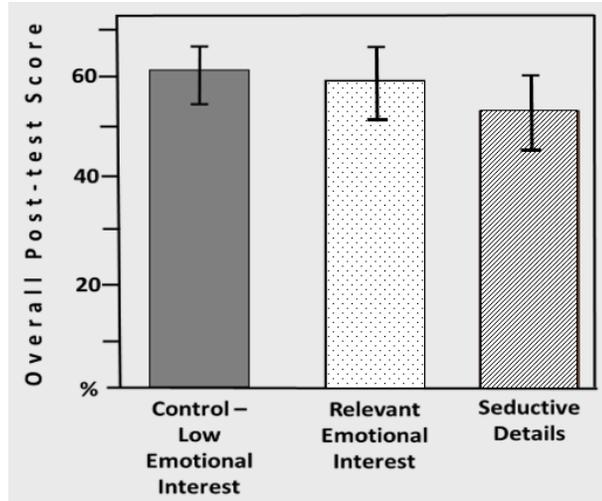
Figure 3 – Effects of the relevance of interest on post-test scores.

The difference between the free recall results and the post-test questionnaire could imply that seductive details are more harmful when encoding more information is necessary for the recall of the learned material. In contrast, when less encoding is needed for recognition tasks, seductive details seem to have less of an impact. However, because the ANOVA result for post-test scores was a value below 1, caution should be used in interpreting the non-significant results. Other interacting and mitigating factors, such as experience level of the learner (Magner et al., 2014), could cause the relationship to appear nonlinear and lead to F values smaller than 1.

4.2   Distinguishing Cognitive Interest and Emotional Interest

Because interactions between cognitive and emotional interest were not statistically significant, the current study was unable to provide any further support to the idea that the two phenomena are distinct constructs. Firstly, the F values were less than one for the interaction, underlining possible other variables at play. Secondly, Hidi's and Renninger's (2006) idea that emotional and cognitive interests are part of the same construct remains

tenable, as does Harp's and Mayer's (1997) idea that a dichotomy exists. However, reassessing the premise of the Harp and Mayer study (1997) provides some indications as to why finding a distinction would be difficult using their methods. While the positive results found by Harp and Mayer (1997) seemed promising for learning based on cognitive interest, the separation between cognitive and emotional interest is problematic. Interest is defined as having both affective and cognitive dimensions, according to Hidi and Renninger (2006). To distinguish the two components would suggest that either an entirely different construct is being studied or that an essential component was neglected when interpreting the results of the study.

The latter could be the case for the Harp and Mayer study (1997). When participants were asked to rate how interesting the learning material was, the average rating for the passage containing cognitively interesting details was not significantly different from the passage with emotionally interesting details, showing that both passages were enjoyed equally, which, in other words, is an experience of positive affect. The interest ratings in all the conditions were greater than 7 out of a possible 10 points. These results demonstrate that there was an emotional response of enjoyment in the cognitive interest conditions equal to that in the emotional interest conditions. Even though the researchers conducted a subsequent experiment to have participants distinguish interest based on "entertainment" as an approximation of emotion and interest based on how much the text supported the learner's understanding, participants initially interpreted "interest" as encompassing both these dimensions. Due to the faulty premise of manipulating only cognitive components of interest with explanative summaries, in addition to the previously discussed problems of repeated exposure when using explanative summaries, finding

nonsignificant results for the interaction between emotional interest and cognitive interest

is not surprising.

CHAPTER 5.   CONCLUSION

Although positive results for relevant interesting details and negative results for seductive details were expected, statistically significant differences were found only for seductive details. These results are more a reflection of the procedure used to determine what information would be considered relevant and interesting. The seductive detail effect, however, did not appear with the post-test questionnaire and could indicate that irrelevant details are only problematic when recall tasks require more encoding. Significant effects were only found for overall scores but not for any sub-scores measuring shallow processing, deep processing, localized attention, or global attention. Such results could indicate that seductive details have more influence on general learning processes, rather than on specific parts of that process.

The current study was unable to contribute to making any distinctions between the constructs of emotional and cognitive interest. This can largely be attributed to the fact that closer attention to construct validity was necessary. Therefore, the lack of significant results for any interactive effects should not be interpreted as indicating that the two constructs are the same or different.

Regardless of these results, the difficulty in developing appropriate manipulations and measures of the experimental effect serves to emphasize the importance of careful planning in the design of instructional material. Generating interest and possibly the right type of interest to increase learning outcomes cannot be a matter requiring merely cursory thought and little consideration. The results of this experiment and the both corroborating and conflicting results in the literature regarding interest and learning illustrate the need

for intentionality in the development of learning content. Failure to make the appropriate considerations can lead to unintended or no results for the attempts made to improve instruction.

There still remains a need for a more substantive basis for beliefs that interest is a necessary motivating factor for learning. Additional studies with improved materials are needed to further explore whether the relevance of high-interest materials can mitigate the detrimental effects of seductive details and support interest learning theory. Finding more empirical evidence would support popular recommendations for stimulating interest in improving educational outcomes, especially for STEM subjects (National Governors Association, 2011). There would even be value from adding to a possible foundation for creating guidelines on how to select interesting information that is appropriate for a learning purpose, particularly with multimedia. If learning improvements cannot be consistently found, then perhaps this can deter misguided efforts in encouraging instruction that is interesting but ineffective.

APPENDIX A. INTERESTINGNESS MATERIALS

The following is the content used in the online surveys regarding interestingness of statements on the human digestive system. The following sets of text samples were presented in random order. Participants were asked to order the texts within each set according to interest. Additionally, each statement was also rated according to how interesting they are on a 7-point Likert-type scale: very uninteresting, mostly uninteresting, somewhat uninteresting, neutral, somewhat interesting, mostly interesting, very interesting.

A.1 Survey Content

Instructions to be included with each set of texts:

Please read the 3 samples of text below. The same information might appear in each of the 3 samples, but some of the information will always be different. Please click and drag the samples in order from most interesting at the top, where most interesting = 1, to least interesting at the bottom.

Set 1

1) Stimulation of the vagus nerve is being studied as a possible treatment of chronic depression in patients who do not respond to other treatments.

2) The vagus nerve also shows potential as a possible means of weight loss. Stimulation of this nerve can lead to sensations of fullness.

3) The surrounding nerves of the digestive system can act as an independent "second brain" if the vagus nerve is severed.

Set 2

1) Although most people can taste the basic qualities of sweet, salty, bitter, sour, and meaty, there are some flavors that only certain people can taste due to genetic differences.

2) The tongue contains around 10,000 taste buds that contribute to our sensation of flavors in food: sweet, salty, bitter, sour, and umami/meaty.

3) The taste buds evolved to allow humans to determine what foods were good for energy (from tastes that are sweet, umami/meaty) or essential minerals (salty tastes) and what foods might be harmful (bitter, sour tastes).

Set 3

1) Saliva is a liquid secreted by the salivary glands and contains an enzyme called amylase that chemically breaks down starch.

2) On a daily basis, the average person produces about 2 liters of enzyme-containing saliva that helps to break down starch..

3) This enzyme amylase is used in commercial laundry detergents to treat stains from starchy foods.

Set 4

1) The large intestine primarily serves as a site for fermentation of indigestible matter by gut bacteria and for reabsorption of water, vitamins, and minerals before excretion. Some vitamins, such as biotin and vitamin K produced by bacteria from fermentation in the colon are also absorbed into the blood in the colon.

2) The large intestine contains microorganisms that are responsible for fermentation of indigestible matter and that produce vitamins that are absorbed by the large intestine. The importance of these microorganisms is highlighted by the fact that a person will carry approximately 3 pounds of bacteria and other microorganisms in his or her digestive tract.

3) Scientists are discovering how important microorganisms are for healthy digestion. The typical human digestive tract contains about 2,000 species of bacteria, fungi, and protozoa, primarily located in the large intestine. By the time a person reaches school age, he or she will have 100 trillion bacteria, which is equivalent to approximately 3 pounds of microorganisms.

Set 5

1) The jaw muscles are the strongest in the human body.

2) Each person's pattern of chewing is unique and as identifying as a set of fingerprints.

3) Chewing without having food enter the stomach, like with chewing gum, can lead to bloating.

Set 6

1) Gastric juice mainly contains hydrochloric acid and pepsin and are strong enough to damage the stomach wall. Although hydrochloric acid is strong enough to corrode metal and can be fatal if inhaled or ingested, the acid itself does not break down food molecules. Instead, it plays an essential role by providing an optimum pH for the reaction of the enzyme pepsin and kills many potentially harmful microorganisms that are ingested with the food.

2) Gastric secretions were first discovered by William Beaumont in the 1820's. By studying a patient who had a gunshot wound to the stomach that had healed without closing, Beaumont observed little papillae producing a clear liquid with the introduction of food directly into the patient's opening into the stomach. Beaumont tasted the secretion, and determined that the salty acid must be responsible for the breakdown of food. However, modern science has discovered that the acid does not break down food, but provides an optimum pH for the enzyme pepsin to digest the proteins in food.

3) The stomach produces each day about 250 mL of secretions that mainly contains hydrochloric acid and pepsin , which are strong enough to damage the stomach wall. The acid itself does not break down food molecules, but rather it provides an optimum pH for the reaction of the enzyme pepsin and kills many potentially harmful microorganisms that are ingested with the food.

Set 7

1) Because the digestive system is not always efficient at extracting the nutrients from food, many animal species will ingest their own dung or undigested food remaining in the feces.

2) Some cultures collect softened seed from animal dung to process into other foods. The most expensive coffee beans in the world are undigested beans collected from the dung of the civet cat in Indonesia.

3) Feces are stored in the rectum for a certain period and then the stored feces are eliminated from the rectum.

Set 8

1) Hydrogen and sometimes methane gases in the gut are flammable, and in 1977, a surgical removal of a polyp from a man's colon led to the internal combustion of these bacterially produced gases.

2) Beans, which have earned a reputation as a flatulence-inducing food, contain indigestible sugars that are broken down by gut bacteria and produce gases in the process.

3) When bacteria ferment partially digested food in the large intestine, hydrogen and sometimes methane gases are formed in the gut as byproducts of this process.

Set 9

1) Much of the gut bacteria is transferred from a mother's birth canal to a baby during natural vaginal birth. Not being exposed to the mother's bacteria is associated with conditions, such as asthma, allergies, type 1 diabetes, and obesity.

2) Much of the gut bacteria is transferred from a mother's birth canal to a baby during natural vaginal birth. Because babies delivered by C-section are not exposed to the healthy

bacteria, researchers are swaddling newborns in gauze soaked in the mothers' vaginal fluids.

3) Much of the gut bacteria is transferred from a mother's birth canal to a baby during natural vaginal birth. Healthy bacteria populations are prevented from populating on and inside the babies' bodies if babies are delivered by C-section, receive antibiotics, or are fed formula.

Set 10

1) When the stomach is empty, the lining folds into wrinkles and ridges, known as rugae.

2) When the stomach is completely expanded, it can hold over a gallon of food.

3) Folds, called rugae, in the stomach lining allow the stomach to expand and also help to grip food during transport.

Set 11

1) Human bite force is not determined by the power of the jaw muscles, but by the ligament that attaches the teeth to the jaw bone. It is also limited by the sensitivity of the teeth.

2) The human bite force of 275 pounds seems rather small compared to the estimated 12,800 pounds of force produced by T. Rex jaws, which scientists believe to be the land animal with the strongest bite force ever known.

3) Even though human bite force is the smallest compared to other great apes, like gorillas and chimpanzees, humans have the strongest bite in relationship to their body size.

Set 12

1) 95% of absorption of nutrients occurs in the small intestine, which is the organ with the largest surface area.

2) The total surface area of the small intestine is estimated to be between 2,700 ft2 – about the size of a tennis court and approximately 100 times the surface area of the exterior of the body.

3) The small intestine's importance is highlighted by the fact that it is the largest organ in the human body by length and surface area.

Set 13

1) The use of bear gallbladders and bile in traditional medicines is creating problems with poaching.

2) High concentration of cholesterol or a substance called billirubin in the bile can lead to the formation of gallstones.

3) Not only does the gallbladder store bile, but it also concentrates it into a form that's best for digestion.

Set 14

1) Most of the air is swallowed when talking and eating while some of it is a byproduct of the digestion.

2) Gas in the gut is primarily composed of carbon dioxide, oxygen, nitrogen, hydrogen, and sometimes methane.

3) Smoking, chewing gum, or even wearing loose-fitting dentures can cause more air to enter the gut.

Set 15

1) The movement of food and fluid through the intestines produces the gurgling sounds. These rumblings are known as borobrygmi.

2) The movement of food and fluid through the intestines produces gurgling sounds. Hyperactive or completely absent rumblings could be signs of abnormal digestive issues.

3) The movement of food and fluid through the intestines produces gurgling sounds. Eating too much sugar can increase the noise in your digestive tract.

Set 16

1) Adults have 32 teeth while young children have 20 teeth. Girls will tend to teeth before boys.

2) The hardest part of the human body is tooth enamel, which covers the visible surface of the teeth.

3) Teeth are not made of bone, but rather layers of tissues of varying density and hardness.

Set 17

1) Because there is a shortage of donors and a great need for donated organs, researchers are experimenting with 3D-printed livers for use in transplant patients.

2) The function of liver is to filters your bloodstream, stores some vitamins and minerals, and help to breakdown certain hormones.

3) The function of the liver is so important that it is the largest human organ by weight and regenerates all its cells within 30 days.

Set 18

1) Cancers of the digestive system cause more cancer-related deaths than any other organ system in the human body.

2) Most of these neuroendocrine cells are found in the GI tract, but some are scattered throughout other parts of the body.

3) When these neuroendocrine cells start growing or behaving abnormally, the form tumors, but these tumors may or may not be cancerous.

Set 19

1) In 1868, German doctor Adolph Kussmaul was the first person to use an endoscope to look inside the stomach of a living person. He recruited a sword swallower to gulp down the 18.5" long inflexible tube of his endoscope.

2) An endoscope is a tube with a series of lenses and light attached on the end. It is used to look inside a body cavity or organ, generally the upper part of the gastrointestinal tract.

3) Endoscopes are usually used to internally examine and diagnose patients, but they can also be used to cauterize areas that are bleeding, cut off growths, and even remove foreign objects.

Set 20

1) Paul Hunn holds the record for the loudest burp at nearly 110 decibels, which is as loud as a chainsaw from 3 feet away.

2) Both the inability to belch or belching excessively could be signs of medical conditions and require medical attention.

3) If the excess air in the gut is not released, the gases can build up and cause bloating and abdominal pain.

A.2 References

The above content was adapted from the following sources:

Abumrad, J., & Krulwich, R. Guts [Season 10 Episode 7]. RadioLab. Podcast retrieved
    from http://www.radiolab.org/story/197112-guts/

Atala, A. (2011). Printing a human kidney [video]. In TED. Retrieved from
    https://www.ted.com/talks/anthony_atala_printing_a_human_kidney?language=e
    n.

Castro, J. (2013). 11 surprising facts about the digestive system. In livescience. Retrieved
    from http://www.livescience.com/40187-digestive-system-surprising-facts.html.

DNews. (2012, November 12). Human bite stronger than thought. Seeker. Retrieved from

http://news.discovery.com/human/evolution/human-bite.htm.

Dominguez-Bello, M. G., De Jesus-Laboy, K. M., Shen, N., Cox, L. M., Amir, A.,
Gonzalez, A., & Mendez, K. (2016). Partial restoration of the microbiota of
Cesarean-born infants via vaginal microbial transfer. Nature medicine, 22, 250-253.

Digestion. (n.d.). In Wikipedia. Retrieved from http://en.wikipedia.org/wiki/Digestion

Endoscopy. (2016). In Wikipedia. Retrieved from
https://en.wikipedia.org/wiki/Endoscopy.

Evan, M. (2015). Amazing facts about teeth!. In Monroe Falls Family Dentistry.
Retrieved from http://www.munroefallsfamilydentistry.com/25-amazing-facts-teeth/.

Haelle, T. (2015). 10 essential facts about your gallbladder. In everydayHEALTH.
Retrieved from http://www.everydayhealth.com/news/essential-facts-about-your-gallbladder/.

Keeton, W.T., Sircus, W., Dworken, H.J., Hightower, N.C., & Sears, A. (2014). Human
digestive system. In Encyclopaedia Britannica. Retrieved from
http://www.britannica.com/EBchecked/topic/1081754/human-digestive-system.

Khoruts, A. (2016). First microbial encounters. Nature medicine. Retrieved from
http://www.nature.com/nm/journal/vaop/ncurrent/full/nm.4042.html.

Kimball, J. (n.d.) The human gastrointestinal (G.I.) tract. In Kimball's Biology Pages.
Retrieved from
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/G/GITract.html.

Kimball, J. (n.d.) Hormones of the gut. In Kimball's Biology Pages. Retrieved from

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/G/GutHormones.html.

Murphy, S. V., & Atala, A. (2014). 3D bioprinting of tissues and organs. Nature

Biotechnology, 32(8), 773-785.

National Cancer Institute. (2016). Gastrointestinal carcinoid tumors treatment – Patient

version. In National Cancer Institute at the National Institutes of Health.

Retrieved from http://www.cancer.gov/types/gi-carcinoid-tumors/patient/gi-

carcinoid-treatment-pdq.

National Institute of Diabetes and Digestive and Kidney Diseases. (2013). The digestive

system and how it works. National Digestive Diseases Information

Clearinghouse. Bethesda MD

National Institute of Health. Retrieved from http://www.niddk.nih.gov/health-

information/health-topics/Anatomy/yourdigestivesystem/Documents/

Digestive_System_508.pdf

Palastanga, N.P., Field, D., & Soames, R. (2006). Anatomy and human movement:

Structure and function. New York: Butterworth Heinmann.

Pierce, T. (2010, November 29). Poaching of bear gallbladders used in traditional

medicine increases. Los Angeles Times. Retrieved from

http://latimesblogs.latimes.com/unleashed/2010/11/bear-gall-bladder-uses.html.

Roach, M. (2013). Gulp. New York: W.W. Norton & Company.

Taylor, T. (n.d.). Stomach. In InnerBody. Retrieved from

http://www.innerbody.com/image_digeov/dige11-new.html#full-description.

Thomspon, W.G. (2016). A noisy tumny: What does it mean?. In International

Foundation for Functional Gastrointestinal Disorders. Retrieved from

http://iffgd.org/symptoms-causes/abdominal-noises.html?showall=.

World's first 3D-bioprinted transplant-ready organ to be unveiled in early 2015. (2014, November 14). In RT News. Retrieved from https://www.rt.com/news/202175-3d-bioprinted-organ-transplant/.

APPENDIX B. RELEVANCE MATERIALS

The following is the content used in the online surveys regarding interestingness of statements on the human digestive system. The following sets of text samples were presented in random order. The statement rated as least interesting on the Interestingness Survey was presented first. Two answer choices were presented in random order, and participants were to choose one that contained more similar information as the first text.

Instructions to be included with each set of texts:

Select the choice below that has more similar information as the text you just read. Set 1

Saliva is a liquid secreted by the salivary glands and contains an enzyme called amylase that chemically breaks down starch.

Option 1 - On a daily basis, the average person produces about 2 liters of enzyme-containing saliva that helps to break down starch..

Option 2 - This enzyme amylase is used in commercial laundry detergents to treat stains from starchy foods.

Set 2

The large intestine primarily serves as a site for fermentation of indigestible matter by gut bacteria and for reabsorption of water, vitamins, and minerals before excretion. Some vitamins, such as biotin and vitamin K produced by bacteria from fermentation in the colon are also absorbed into the blood in the colon.

Option 1 - The large intestine contains microorganisms that are responsible for fermentation of indigestible matter and that produce vitamins that are absorbed by the large intestine. The importance of these microorganisms is highlighted by the fact that a person will carry approximately 3 pounds of bacteria and other microorganisms in his or her digestive tract.

Option 2 - Scientists are discovering how important microorganisms are for healthy digestion. The typical human digestive tract contains about 2,000 species of bacteria, fungi, and protozoa, primarily located in the large intestine. By the time a person reaches school age, he or she will have 100 trillion bacteria, which is equivalent to approximately 3 pounds of microorganisms.

Set 3

The stomach produces each day about 250 mL of secretions that mainly contains hydrochloric acid and pepsin , which are strong enough to damage the stomach wall. The acid itself does not break down food molecules, but rather it provides an optimum pH for the reaction of the enzyme pepsin and kills many potentially harmful microorganisms that are ingested with the food.

Option 1 - Gastric juice mainly contains hydrochloric acid and pepsin and are strong enough to damage the stomach wall. Although hydrochloric acid is strong enough to corrode metal and can be fatal if inhaled or ingested, the acid itself does not break down food molecules. Instead, it plays an essential role by providing an optimum pH for the reaction of the enzyme pepsin and kills many potentially harmful microorganisms that are ingested with the food.

Option 2 - Gastric secretions were first discovered by William Beaumont in the 1820's. By studying a patient who had a gunshot wound to the stomach that had healed without closing, Beaumont observed little papillae producing a clear liquid with the introduction of food directly into the patient's opening into the stomach. Beaumont tasted the secretion, and determined that the salty acid must be responsible for the breakdown of food. However, modern science has discovered that the acid does not break down food, but provides an optimum pH for the enzyme pepsin to digest the proteins in food.

Set 4

Feces are stored in the rectum for a certain period and then the stored feces are eliminated from the rectum.

Option 1 - Because the digestive system is not always efficient at extracting the nutrients from food, many animal species will ingest their own dung or undigested food remaining in the feces.

Option 2 - Some cultures collect softened seed from animal dung to process into other foods. The most expensive coffee beans in the world are undigested beans collected from the dung of the civet cat in Indonesia.

Set 5

Healthy bacteria populations are prevented from populating on and inside the babies' bodies if babies are delivered by C-section, receive antibiotics, or are fed formula.

Option 1 - Not being exposed to the mother's bacteria is associated with conditions, such as asthma, allergies, type 1 diabetes, and obesity.

Option 2 - Because babies delivered by C-section are not exposed to the healthy bacteria, researchers are swaddling newborns in gauze soaked in the mothers' vaginal fluids.

Set 6

When the stomach is empty, the lining folds into wrinkles and ridges, known as rugae.

Option 1 - When the stomach is completely expanded, it can hold over a gallon of food.

Option 2 - Folds, called rugae, in the stomach lining allow the stomach to expand and also help to grip food during transport.

Set 7

Gas in the gut is primarily composed of carbon dioxide, oxygen, nitrogen, hydrogen, and sometimes methane.

Option 1 - Most of the air is swallowed when talking and eating while some of it is a byproduct of the digestion.

Option 2 - Smoking, chewing gum, or even wearing loose-fitting dentures can cause more air to enter the gut.

Set 8

Adults have 32 teeth while young children have 20 teeth. Girls will tend to teeth before boys.

Option 1 - The hardest part of the human body is tooth enamel, which covers the visible surface of the teeth.

Option 1 - Teeth are not made of bone, but rather layers of tissues of varying density and hardness.

Set 9

The function of liver is to filters your bloodstream, stores some vitamins and minerals, and help to breakdown certain hormones.

Option 1 - Because there is a shortage of donors and a great need for donated organs, researchers are experimenting with 3D-printed livers for use in transplant patients.

Option 2 - The function of the liver is so important that it is the largest human organ by weight and regenerates all its cells within 30 days.

Set 10

Most of these neuroendocrine cells that can form tumors are found in the GI tract, but some are scattered throughout other parts of the body.

Option 1 - Cancers of the digestive system cause more cancer-related deaths than any other organ system in the human body.

Option 2 - When these neuroendocrine cells start growing or behaving abnormally, the form tumors, but these tumors may or may not be cancerous.

Set 11

An endoscope is a tube with a series of lenses and light attached on the end. It is used to look inside a body cavity or organ, generally the upper part of the gastrointestinal tract.

Option 1 - In 1868, German doctor Adolph Kussmaul was the first person to use an endoscope to look inside the stomach of a living person. He recruited a sword swallower to gulp down the 18.5" long inflexible tube of his endoscope.

Option 2 - Endoscopes are usually used to internally examine and diagnose patients, but they can also be used to cauterize areas that are bleeding, cut off growths, and even remove foreign objects.

APPENDIX C. VIDEO SCRIPTS

The following are the scripts that were read in the videos on human digestion. Highlighted sections indicate the content that was changed in the different conditions.

C.1   Control Video Script

Slide 1 (http://paleomagazine.com/wp-content/uploads/2013/07/digestion2.jpg)

Digestion is the breakdown of food into smaller components that are more

easily absorbed into the blood stream.

Slide 2 (http://www.georgeretseck.com/medical_files/taste.jpg)

It's a very complex process that requires an intricate communication system with the

brain through hormones, neurotransmitters, nerves, and even gut bacteria. Much of the

digestive system's functions are controlled by over two dozen hormones found in

different parts of the gastrointestinal system. Many of them are actually found outsides of

the digestive tract, such as in the brain. There are two types of nerves that control the

digestive process.

Slide 3

Extrinsic nerves, such as the vagus nerve between the gut and brain, control the

contractions of the muscles in the gastrointestinal tract.

Slide 4

Intrinsic nerves inside the tract are stimulated by the stretching of the walls of the digestive organs when food enters. The nerves lead to the release of enzymes and other chemicals.

Slide 5 (https://helix.northwestern.edu/sites/helix/files/brain_helix.jpg)

Digestion begins before food even enters the stomach and involves preparing the body to eat. In this first stage, called the cephalic stage, sight, smell, thought, and sound stimulate the brain. When smells reach the brain, the brain sends signals through a major nerve connecting to the gut. This leads to an increase of gastric juices in preparation for the food that will enter the digestive tract.

Slide 6 (https://www.sundhed.dk/borger/sygdomme-a-aa/mave-og-tarm/illustrationer/animationer/syreneutraliserende-medicin/)

Once food actually enters the mouth, mechanical digestion of the food starts with mastication, or chewing.

Slide 7

(http://www.3dscience.com/img/Products/3D_Models/Human_Anatomy/Teeth/Teeth_Mouth_Gums_Nerves/supporting_images/teeth-interior.jpg)

As omnivores, humans have sharper edged teeth towards the front of the mouth for cutting and tearing meat

Slide 8

while the teeth in the back are flatter and ridged for crushing plants. Even though they might look similar, teeth are not bones. They are actually made of tissues of different densities and hardnesses. These tissues are called enamel, dentine and cementum.

Slide 9

However, like many bones, human teeth have a blood and nerve supply which enables proprioception. Proprioception is the ability to feel when chewing. Feeling is important to make sure you aren't chewing something too hard and also to sense whether the food is staying between your teeth or not.

Slide 10 (http://www.anatomy-diagram.info/wp-content/uploads/2015/12/human-tongue-anatomy-muscle-3d-56650d765c3c2.jpg)

The tongue, with the help of the cheeks, is what keeps the food between the teeth for chewing. It also helps to shape the food into a round bolus and pushes that bolus toward the back of the throat for swallowing. The tongue contains around 10,000 taste buds for sensing flavors in food: sweet, salty, bitter, sour. These flavors tell us what kind of chemicals might be in our foods.

Slide 11 (http://cdn2.hubspot.net/hub/189659/file-28973555-jpg/images/salivary-glands.jpg?t=1461329104988)

The tongue is sensitive and kept moist by saliva, some of which is produced by the tongue itself. Saliva, a liquid secreted mostly by three pairs of salivary glands in your mouth, contains an enzyme which starts the chemical breakdown of starch in the

58

food. This enzyme in saliva is known as amylase. The saliva and mucus in your mouth lubricate the food to make swallowing easier. Another role of saliva is to keep your mouth healthy. It does so by keeping the mouth and teeth relatively free of residue, limiting bacterial growth, and providing one way of ridding your body of certain waste substances, such as mercury, alcohol, and some antibiotics. Saliva is continuously secreted in the mouth, even without food. However, when there is physical contact between an object and the gums, tongue, or other part of the mouth lining, the amount of saliva increases. This is a completely involuntary reflex. In contrast, salivating at the sights, smells, sounds of food is considered a learned reflex.

Slide 11

(http://img.medscape.com/thumbnail_library/is_150917_esophagus_stomach_intestines_ 800x600.jpg)

When food is swallowed, it travels down the esophagus and into the stomach. The esophagus is the narrow first 8-12 inches of your digestive tract, and the walls are actually the beginning of a continuous double layer of muscles that lead to the colon and make up the digestive tract.

Slide 13 (http://www.buzzle.com/img/articleImages/372527-42815-53.jpg)

At the top of this tract, is a flap of tissue called the epiglottis that closes when swallowing to prevent food from entering the windpipe. Slow contractions of the muscles in your esophagus push the food down to the stomach, and this process take about 7-10 seconds.

Slide 14 (http://hansacenter.com/wp-content/uploads/2013/10/stomach-acid-810x400.jpg)

The gastric phase takes 3 to 4 hours once food enters the stomach. The stomach is a small, 'J'-shaped pouch in the upper left of your abdomen with walls made of thick, stretchy muscles. The stomach lining is covered with millions of gastric glands, which contain several types of cells.

Slide 15 (https://upload.wikimedia.org/wikipedia/commons/5/5a/Parietal_cells.jpg)

Hormone-secreting cells, release several hormones and neurotransmitters, such as serotonin, which signal that a person is full. A second type of cells, gastrin cells, release the hormone gastrin when the food arrives in the stomach. The gastrin stimulates 2 other types of cells: chief cells and parietal cells. Chief cells produce the building block for the enzyme pepsin that breaks down protein. Parietal cells secrete hydrochloric acid and a protein called gastric intrinsic factor. Gastric intrinsic factor binds to vitamin B_{12} so that it can later be absorbed in the small intestine.

Slide 16 (http://wonderopolis.org/_img?img=/wp-content/uploads/2014/12/1374_f.jpg&transform=resizeCrop,720,450)

The gastric phase is triggered when food expands the stomach and the acidity inside the stomach decreases to a pH of 3. The contents of your stomach will stay at this highly acidic level for about 90 minutes. Digestion of carbohydrates continues, and protein breakdown begins. However, contrary to common beliefs, the stomach is not the primary site for digestion. The hydrochloric acid doesn't actually break down food molecules but, instead, provides an optimum pH for activating the enzyme pepsin. The low pH also

kills many microorganisms that are ingested with the food. Because both pepsin and

hydrochloric acid can damage the stomach walls, mucus-secreting cells form a slimy

mucus layer along the stomach.

Slide 17 (http://medimagery.com/anatomy/stomach/gastric_layers.png)

There are three types of muscle contractions seen in the stomach muscles.

Slide 18

The first type of muscle contractions comes from the striated muscles. A small back-and-

forth wave in the stomach wall from the upper part to the lower indent the stomach wall

and serve to mix and crush the food.

Slide 19

These contractions are followed by a second type of contraction made of waves from

smooth muscles that create deeper indentations in the stomach. These indentations serve

to divide the stomach cavity into compartments and pump the food into the

small intestines. The pumping out of the stomach is called retropulsion and allows the

food to break down even more. Both types of muscles activity occur with a frequency of

about three contractions per minute.

Slide 20

(http://faculty.icc.edu/rnrs/rnrs221/gastrointestinal/assets/graphics/stomach2_Rugae.jpg)

The final type of activity can occur simultaneously with the other two types of contractions. Instead of waves, the gastric wall muscles will sustain a contraction in order to decrease the size of the stomach as the contents empty. When the stomach is empty, the lining folds into wrinkles and ridges, known as rugae.

Slide 21

How quickly your stomach empties depends what you ate. Liquids empty more quickly from the stomach than solids. For solids, carbohydrates are the fastest to digest, then proteins, and then fats. The food that leaves the stomach is in the form of a semi-liquid called chyme, which is a mixture of the food and digestive enzymes.

Slide 22

(http://img.webmd.com/dtmcms/live/webmd/consumer_assets/site_images/articles/health _tools/type_1_diabetes_overview_slideshow/princ_rf_photo_of_xray_of_pancreas.jpg) The chyme leaves the stomach through the pyloric sphincter and enters the duodenum, which is the first section of the small intestine. Muscles of the small intestine work to mix the chyme with three different liquids: bile from the liver, pancreatic juice, and intestinal juice. The chyme becomes less acidic in the small intestine from these alkaline fluids. The higher pH helps enzymes in bile to activate and begin the breakdown of fat. Between meals, bile is stored in the gallbladder. Pancreatic and intestinal juices also contain other enzymes to complete protein and starch digestion. The presence of the food and digestive juices triggers intestinal hormones to be released, causing the pyloric

sphincter to tighten to prevent more food from entering back into the stomach. 95% of absorption of nutrients occurs in the small intestine.

Slide 23 (http://www.blitzquotidiano.it/wp/wp/wp-content/uploads/2015/01/intestino.jpg) The small intestine is a little over an inch in diameter and 21 feet long, but concentric folds in the lining and small, finger-like protrusions called villi covered with even more microvilli increase the surface area. The massive surface area allow for speedy absorption of nutrients and water.

Slide 24 (https://pmgbiology.files.wordpress.com/2015/12/kessel-shih-the-finger-like-villi-in-the-mammal-small-intestine-mucosa-greatly-increase-the-surface-area.jpg?w=540)
Specialized cells at the surface of the villi have membranes, called a brush border, that contain pores for transporting the nutrients for absorption. The glucose, amino acids from protein, some vitamins and minerals that are absorbed into the blood enter the liver for filtering, removal of toxins, and nutrient processing. Fatty acids and some vitamins are absorbed into the lymphatic system, which carry a clear liquid called lymph filled with white blood cells. The villi of the small intestine also contain Paneth cells, which produce an enzyme called lysozyme sterilizes the contents of the small intestine.

Slide 25 (http://www.asiabiotech.com/20/2003/graphics/20030018b.jpg)

In addition to producing bile, the liver functions to filter your bloodstream, store some vitamins and minerals, and help to breakdown some of the excess hormones in the blood. After starch digestion is complete, the resulting smaller glucose molecules enter the bloodstream to provide the body with energy.

Slide 26 (http://www.wallstreetotc.com/wp-content/uploads/2014/08/colon-cancer.jpg) After the food has been passed through the small intestine, the food enters the large intestine, or colon. In humans, the large intestine is roughly 4 feet long.

Slide 27 (http://i.huffpost.com/gen/2437146/images/o-GUT-BACTERIA-facebook.jpg) The large intestine primarily serves as a site for fermentation of indigestible food matter by gut bacteria and for reabsorption of water, vitamins, and minerals before excretion. Some vitamins, such as biotin and vitamin K produced by bacteria from in the colon are also absorbed into the blood in the colon. Gut bacteria are responsible for fermenting the indigestible food, such as fiber, into gases and acids. Flatulence-inducing gases are byproducts of this process. Gas in the gut is primarily composed of carbon dioxide, oxygen, nitrogen, hydrogen, and sometimes methane. Physicians can measure how long hydrogen takes to appear in the breath after eating glucose to determine whether the GI tract is colonized by bacteria. Hydrogen appearing within 30 minutes is an indicator of heavy colonization by gut flora of the small intestine and a sign of a healthy gut.

Slide 28

(http://us.123rf.com/450wm/Eraxion/Eraxion1410/Eraxion141000258/32387701-

medical-3d-illustration-of-the-rectum.jpg?ver=6)

Food products that cannot be absorbed through the villi in the large intestine, such

as dietary fiber, are mixed with other waste products from the body and become solid and

concentrated feces. The waste products are essentially undigested food materials of an

inefficient digestive system and can still contain nutrients that the body was unable to

absorb. Muscle activity ensures that the waste matter is mixed with mucus for lubrication.

These muscle contractions in the colon are first stimulated by chewing during the

cephalic phase, the first phase of digestion. The contractions can also be stimulated by the

presence of fat, hormones, and bile acids that enter the large intestine. The feces are

stored in the rectum, which is the lower part of the large intestine, for a certain period

before the stored feces are finally eliminated from the body.

Slide 29 (http://paleomagazine.com/wp-content/uploads/2013/07/digestion2.jpg)

The whole digestive system is around 27 feet long. In a healthy human adult this process

can take between 24 and 72 hours. Food digestion physiology varies between individuals

and depends upon other factors such as the type of food and size of the meal.

Slide 30

(https://lh3.googleusercontent.com/XU5dtuETMJSuCnaVYRVkjAlPYRpB66Ki7NWxX

7xk2eA7zG9ASYwdRFg73ONur9Oqkw=h900)

Doctors are able to use special instruments to learn about digestion. Endoscopes are used to study the digestive tract. An endoscope is tube with a series of lenses and light attached on the end. It is used to look inside a body cavity or organ, general the upper part of the gastrointestinal tract.

Slide 31 (http://i.livescience.com/images/i/000/057/633/original/digestive-system-131004.jpg)

Despite all the knowledge we've gained over the past couple hundred years, much about the human digestive tract is still unknown. Given the intricacies of digestion, it is unsurprising that there is so much uncertainty and controversy surrounding contemporary health issues such as obesity, weight loss fads, benefits of particular types of foods, and the role of diet in other diseases.

C.2 Relevant Interest Video Script

Highlighted sections in the Control Script were substituted with the following:

Slide 11 - Saliva contains an enzyme, called amylase, which is used in commercial laundry detergents to treat stains from starchy foods.

Slide 20 - the gastric wall muscles will sustain a contraction in order to decrease the size of the stomach as the contents empty. Folds, called rugae, in the stomach lining allow the stomach to expand and also grip food during transport.

Slide 25 - Because its bile-producing and blood-filtering jobs are so important, the liver is the largest human organ by weight and regenerates all its cells within 30 days.

Slide 27 - The large intestine contains microorganisms that are responsible for fermentation of indigestible matter and that produce vitamins that are absorbed by the large intestine. The importance of these microorganisms is highlighted by the fact that a person will carry approximately 3 pounds of bacteria and other microorganisms in his or her digestive tract.

Slide 27 - Only some of the gas is a byproduct of digestion while most of the air in the digestive tract is swallowed when talking and eating.

Slide 27 - Because the digestive system is not always efficient at extracting the nutrients from food, many animal species will ingest their own dung or undigested food remaining in feces.

Slide 28 - Endoscopes are used to study the digestive tract. Endoscopes are usually used to internally examine and diagnose patients, but they can also be used to cauterize areas that are bleeding, cut off growths, and even remove foreign objects.

C.3 Irrelevant Interest/Seductive Details Video Script

Highlighted sections in the Control Script were substituted with the following:

Slide 11 - On a daily basis, the average person produces about 2 liters of saliva, which contains the enzyme amylase, responsible for breaking down starches.

Slide 20 - The gastric wall muscles will sustain a contraction in order to decrease the size of the stomach as the gastric contents empty. When the stomach is completely expanded, it can hold over a gallon of food.

Slide 23 - Because there is a shortage of donors and a great need for donated organs, researchers are experimenting with 3D-printed livers for use in transplant patients.

Slide 27 - Scientists are discovering how important microorganisms are for healthy digestion. The typical human digestive tract contains about 2,000 species of bacteria, fungi, and protozoa, primarily located in the large intestine. By the time a person reaches school age, he or she will have 100 trillion bacteria, which is equivalent to approximately 3 pounds of microorganisms.

Slide 27 - Smoking, chewing gum, or even wearing loose-fitting dentures also can cause more air to enter the gut.

Slide 28 - Some cultures collect softened seed from animal dung to process into other foods. The most expensive coffee beans in the world are undigested beans collected from the dung of the civet cat in Indonesia.

Slide 30 - Endoscopes can be used by doctors to study the digestive tract. In 1868, German doctor Adolph Kussmaul was the first person to use an endoscope to look inside the stomach of a living person. He recruited a sword swallower to gulp down the 18.5" long inflexible tube of his endoscope.

C.4   Explanative Summaries for Cognitive Interest

The Control, Relevant Interest, and Irrelevant Interest scripts contained explanative summaries and concept highlights to provide cognitive interest.

Slide 5 - Digestion is the breakdown of food into nutrients for absorption into the body. Communication among the nervous system, sensory organs, digestive system, and bacteria allows the body to carry out the complex processes involved in digestion.

Slide 11 - Teeth mechanically break down food, and saliva has enzymes for chemical digestion. The tongue helps to move the food and has tastebuds for particular chemicals. This readies the food for swallowing.

Slide 20 - After traveling through the esophagus, the food enters the stomach. The low pH of the stomach kills bad bacteria and activates pepsin to digest food molecules. Stomach contractions help to mix and move the food in the gastric phase.

Slide 24 - Chyme has a higher pH than stomach acid and helps to activate enzymes from liver, pancreatic, and intestinal juices. These enzymes digest fats, proteins and starches. The liver also filters the blood. Most nutrients are absorbed in the small intestine so features like villi increase surface area and allow nutrients to pass into the bloodstream.

Slide 28 – Presence of bacteria in the large intestine means indigestible material can be fermented and broken down. Waste material is also stored here until they are eliminated.

Slide 30 - Endoscopes and other technologies help doctors study the digestive tract. Yet, much remains unknown about the digestive system.

APPENDIX D. TESTING INSTRUMENTS

The following are the questionnaires and prompts used before and after participants watched the videos.

D.1 Preliminary Questionnaire

The Preliminary Questionnaire contained a section for demographic information, interest scales, and prior knowledge questions.

D.1.1 Preliminary Questionnaire Content

Personal Information

Age: _____

Year (circle one):   freshman   sophomore   junior   senior   other _____

Major:_____   Minor:_____

GPA out of 4.0: _____

SAT/ACT math: _____   SAT/ACT verbal: _____

Preliminary Questionnaire

Please answer the following questions to the best of your abilities.

1) How interesting do you find biological sciences? (circle one number)

1	2	3	4	5
uninteresting	somewhat interesting	neither interesting or uninteresting	somewhat interesting	interesting

2) How interesting do you find human anatomy and physiology? (circle one number)

1	2	3	4	5
uninteresting	somewhat interesting	neither interesting or uninteresting	somewhat interesting	interesting

3) How interested are you in learning about digestion and the digestive system? (circle one number)

1	2	3	4	5
uninterested	somewhat uninterested	neither interested or uninterested	somewhat interested	interested

4) How interested are you in human health and diet? (circle one number)

1	2	3	4	5
uninterested	somewhat uninterested	neither interested or uninterested	somewhat interested	interested

5) True or false: <u>Chemical</u> digestion begins in the mouth. _____

6) The organ responsible for most of the digestive processes in humans is the

_____.

7) Which of the following are parts of the human digestive system and processes? Circle

all correct answers.

a. bacteria   c. vagus nerve

b. hormones   d. trachea

8) Circle one answer. The human digestive process takes:

    a. 1-3 minutes   c. 1-3 days

    b. 1-3 hours   d. 1-3 weeks

9) What role does appropriate pH levels play in digestion?

10) What protects the lining of the stomach from the corrosive effects of hydrochloric

    acid? _____

11) Which is NOT a process that is a part of digestion? Circle one answer

    a. cementum   c. fermentation

    b. deglutition   d. peristalsis

12) Which of the following does the digestive system use to protect itself and the body?

    Circle all correct answers.

    a. tastebuds   c. hydorchloric acid

    b. mucus   d. bile

13) Why is it necessary for digestion to have an excitatory component and an inhibitory

    component?

14) True or false: The average adult human digestive tract is about 3 meters long.

_____

15) The fact that humans have both sharp teeth and flatter, ridged teeth indicates that

people are _____. Circle one correct answer.

    a. herbivores   c. carnivores

    b. insectivores   d. omnivores

16) What senses are important for digestion? Circle all correct answers.

    a. hearing   c. seeing

    b. smelling   d. tasting

17) Name one neurotransmitter involved in digestion.

18) Why would neurotransmitters be necessary for digestion?

19) When food is swallowed, it enters a muscular tube called the _____.

20) The mixture of food and digestive enzymes in the stomach is called_____. Circle one

correct answer.

    a. chyme   c. chimera

    b. chicharron   d. charos

21) The small intestine is _____ than the large intestine.

    a. shorter

    b. longer

22) How can chewing gum lead to bloating in the digestive tract?

23) A newborn infant begins developing healthy gut bacteria from the transfer of bacteria from its mother's birth canal. What might be the problem with a baby that was delivered by C-section or given antibiotics for an infection?

24) Proprioception is the ability to feel. Why would proprioception in the teeth limit how forcefully a person would bite a food?

25) The digestive process produces noises. What could the absence of any gurgling noise indicate?

26) The mixture of food and digestive juices becomes _____ acidic in the small intestine.
   a. more
   b. less

27) Why might starches be one of the first food components to start breaking down in digestion?

28) True or false: The stomach needs to communicate with other organs outside of the digestive tract. _____

29) Digestion in adult humans occurs in different amounts of time. What is one reason

for a range of times?

D.1.2 Preliminary Questionnaire Answer Key

5) **shallow** - True or false: Chemical digestion begins in the mouth.   *True.*

6) **shallow** - The organ responsible for most of the digestive processes in humans is the

small intestine.

7) **shallow** - Which of the following are parts of the human digestive system and

processes? Circle all correct answers.

  a. bacteria   *c. vagus nerve*

  b. hormones

8) **shallow** - Circle one answer. The human digestive process takes:

  c. 1-3 days

9) **shallow** - What role does appropriate pH levels play in digestion?

Correct pH levels help activate enzymes that break down food.

10) **shallow** - What protects the lining of the stomach from the corrosive effects of

hydrochloric acid?   *Mucus*

11) **shallow** - Which is NOT a process that is a part of digestion? (circle one answer)

  a. cementum

12) **shallow** - Which of the following does the digestive system NOT use to protect itself

and the body? Circle all correct answers.

  a. tastebuds   *c. hydorchloric acid*

  b. mucus

13) **deep** – Why is it necessary for digestion to have an excitatory component and an inhibitory component?

   - *Excitatory component signals hunger and eating*

   - *Inhibitory component signals satiation and stops eating*

14) **shallow** - True or false: The average adult human digestive tract is about 3 meters long.   *False*

15) **deep** – The fact that humans have both sharp teeth and flatter, ridged teeth indicates that people are _____. Circle one correct answer.   *D. omnivores*

16) **deep** – What senses are important for digestion? Circle all correct answers.

   A. hearing, B. seeing, C. smelling, D. tasting

17) **shallow** - Name one neurotransmitter involved in digestion.

   Serotonin/noradrenaline/gastrin/acetylcholine

18) **deep** – Why would neurotransmitters be necessary for digestion?

   communicating with other organs within the body, like the brain

19) **shallow** - When food is swallowed, it enters a muscular tube called the___.

   esophagus

20) **shallow** - The mixture of food and digestive enzymes in the stomach is called_____.
   Circle one correct answer.   *A. chyme*

21) **shallow** - The small intestine is _____ than the large intestine.   *B. longer*

22) **deep** – How can chewing gum lead to bloating in the digestive tract?   *Chewing gum leads to swallowing extra air that can become trapped in the digestive tract.*

23) **deep** – A newborn infant begins developing healthy gut bacteria from the transfer of bacteria from its mother's birth canal. What might be the problem with a baby that was delivered by C-section or given antibiotics for an infection? *The baby cannot develop healthy gut bacteria*

24) **deep** – Proprioception is the ability to feel. Why would proprioception in the teeth limit how forcefully a person would bite a food? *Sensing foods too hard to bite would keep someone from biting too hard.*

25) **deep** – The digestive process produces noises. What could the absence of any gurgling noise indicate? *Digestive tract is not working/digestion is not happening*

26) **shallow** - The mixture of food and digestive juices becomes _____ acidic in the small intestine.

　　B. less

27) **deep** – Why might starches be one of the first food components to start breaking down in digestion? *They provide the body with the most easily accessible form of energy.*

28) **deep** – True or false: The stomach needs to communicate with other organs outside of the digestive tract. _____ *True*

29) **deep** – Digestion in adult humans takes between 24 and 72 hours. What is one reason for a range of times? *Size of meal/content of meal/individual physiology*

D.2   Exit Questionnaire

The Exit Questionnaire contained duplicate interest scales from the Preliminary Questionnaire, a free recall prompt, and questions regarding the content from the videos.

The interest scales and the free recall prompt were administered first. Upon completion, the remaining questions were given.

D.2.1 Exit Questionnaire Content – Part I

Please answer the following questions to the best of your abilities.

1) How interesting do you find biological sciences? (circle one number)

1	2	3	4	5
uninteresting	somewhat interesting	neither interesting or uninteresting	somewhat interesting	interesting

2) How interesting do you find human anatomy and physiology? (circle one number)

1	2	3	4	5
uninteresting	somewhat interesting	neither interesting or uninteresting	somewhat interesting	interesting

3) How interested are you in learning more about digestion and the digestive system?

(circle one number)

1	2	3	4	5
uninterested	somewhat uninterested	neither interested or uninterested	somewhat interested	interested

4) How interested are you in learning more about human health and diet? (circle one

number)

1	2	3	4	5
uninterested	somewhat	neither	somewhat	interested

	uninterested	interested or uninterested	interested

5) Please describe the process of human digestion. Write as much as you can remember from the video that you just finished watching. You will not be penalized for grammar or spelling, but please try to write as legibly as possible.

D.2.2 Exit Questionnaire Content – Part II

Please answer the following after reading the questions carefully.

6) The enzyme amylase is responsible for breaking down what type of nutrients in food? Circle all correct answers.

    a. Fats   c. Proteins

    b. Starches   d. Bitter chemicals

7) Which type of food would begin breaking down chemically first in the mouth? Circle all correct answers.

    a. High-protein steak   c. Fatty and high-protein bacon

    b. Fibrous and watery celery   d. Starchy cracker

8) Identify one organ that is part of the digestive process but is not part of the digestive tract._____

9) What role would sights, smells, sounds, and thoughts of food have for digestion?

10) When the stomach muscles are not continually holding a contraction, the size of the

   stomach is ____. Circle one correct answer.

   a. smaller
   b. larger

11) Rugae are _____ in the lining of the stomach.

12) Why would it be evolutionarily advantageous to taste different flavors in food?

   Circle all correct answers.

   a. To identify nutritious foods   c. To identify poisonous foods
   b. To identify foods that should be washed d. To identify foods that can be
      cooked

13) What are the two roles of the tongue?

   a. Mechanical

   _____

   b. Chemical/sensory_____

14) Which analogy would be the most appropriate? The liver is like a _____ for

   the digestive system. Circle one answer.

   a. sieve   c. blender
   b. power plant   d. warehouse

15) True or false: The liver produces chime. _____

16) Serotonin is a neurotransmitter that contributes to feeling of contentment and

   happiness. What would reasons why this neurotransmitter be released when the

   stomach is full? Circle all correct answers.

   a. To trigger addictions   c. To motivate eating certain foods
   b. To cause emotional problems   d. To signal when to stop eating

17) True or false: Hydrochloric acid's primary role in the stomach is to break down food

in the stomach. _____

18) Order the following items from fastest to slowest to empty from the stomach:

proteins, starches, fats, liquids

_____   _____   _____   _____

   1(fastest)   2   3   4(slowest)

19) Villi in the small intestine increase the surface area. Why is it so important for the

small intestine to have a large surface area?

20) The large intestine contains many _____ , which

contribute to the fermentation process.

21) Why are bacteria important for digestion?

22) True or false: Flatulence, or gas, is one possible effect from eating indigestible

ingredients. _____

23) What gases are found in the gut? Circle all correct answers.

     a. neon   c. propane
     b. hydrogen   d. helium

24) What is the main lubricant for the digestive system?

25) The adult digestive tract is about 27 feet long. Why does it need to be this long?

26) _____ fibers are an example of an indigestible

component of food that becomes a waste product.

27) We know that the digestive process is _____ because of the

   indigestible material that is eliminated from the body as feces. Circle one answer.

   a. inefficient   c. efficient
   b. combustible   d. incombustible

28) What are endoscopes?

29) True or false: Endoscopes can be used to diagnose hormonal imbalances that affect

   digestion. _____

30) True or false: Human digestion is well-understood. _____

C.2.3   Free Recall Scoring Guide

Points were allotted for each statement, with a maximum total of 62 points, according to

the following scoring scheme:

1 point = correct concept/main idea, key vocabulary is correct

½ point = correct concept/main idea, vocabulary may be slight wrong or subconcepts may

be slightly incorrect or incomplete

0 points = incorrect concept

Key points that were in the video scripts were as follows:

1. Digestion is the breakdown of food into smaller components to be absorbed into

   the blood stream.

2. Digestion requires communication among the brain through hormones, neurotransmitters, nerves, gut bacteria, and digestive organs

3. Extrinsic nerves control the contractions of the muscles in the gastrointestinal tract.

4. Intrinsic nerves signal the release of hormones.

5. Digestion begins during the cephalic stage before food even enters the mouth.

6. All the senses activated by food can stimulate the release of gastric juices.

7. Mechanical digestion of the food starts with chewing.

8. Sharper edged teeth are located towards the front of the mouth for cutting and tearing meat.

9. The teeth in the back are flatter and ridged for crushing plants.

10. Teeth are made of enamel, dentine, and cementum.

11. Teeth have a blood and nerve supply which enables proprioception, or the ability to feel when chewing.

12. The tongue keeps the food between the teeth for chewing.

13. The tongue helps to shape the food into a round bolus.

14. The tongue pushes that bolus toward the back of the throat for swallowing.

15. The tongue senses flavors and chemicals in food.

16. Saliva lubricates the mouth.

17. Saliva contains the enzyme amylase, which breaks down starch.

18. The esophagus is a muscular tube that leads to the stomach.

19. The epiglottis is a flap of tissue in the throat.

20. The epiglottis closes when swallowing to prevent food from entering the windpipe.

21. The gastric phase starts once food enters the stomach.

22. The stomach is a small, muscular pouch in the abdomen.

23. The wall of the stomach release hormones and neurotransmitters, enzymes, and hydrochloric acid.

24. Serotonin signals that a person is full.

25. The contents of the stomach is highly acidic level from the hydrochloric acid.

26. Hydrochloric acid activates pepsin for protein digestion

27. Hydrochloric acid kills bacteria.

28. Mucus layer along the stomach walls protects the body from the strong acids.

29. Muscle contractions seen in the stomach muscles mix and crush the food

30. Muscle contractions pump the food into the small intestines.

31. The muscle contractions shrink the stomach when the stomach is empty.

32. Retropulsion is the pumping of food from the stomach to the small intestine.

33. Rugae are the wrinkles/folds in the lining of the stomach when it is empty.

34. How quickly your stomach empties depends what you ate.

35. Foods digest from fastest to slowest: liquids, starches, proteins, fats

36. Chyme is the mixture of the food and digestive enzymes that leaves the stomach.

37. The duodenum is the first section of the small intestine.

38. Chyme mixes with bile from the liver, pancreatic juice, and intestinal juice.

39. The mixture becomes less acidic in the small intestines.

40. Higher pH/less acidity allows fat breakdown to begin.

41. The liver filters the bloodstream.

42. Glucose passes through the liver into the bloodstream.

43. Villi, small fingerlike protrusions, and microvilli, greatly increase surface area in the small intestine.

44. Large surface area allows for speedy absorption of nutrients and water.

45. Most of digestion occurs in the small intestine.

46. Lysozyme sterilizes the contents of the small intestine.

47. After the food has been passed through the small intestine, the food enters the large intestine/colon.

48. The large intestine contains gut bacteria.

49. Gut bacteria ferment indigestible food material (fiber).

50. Bacteria produce gases from fermentation.

51. Gas in the gut can indicate the presence of bacteria in the large intestine.

52. The large intestine absorbs water and some vitamins and minerals.

53. Feces are food material that can't be absorbed/digested and mixed with other waste products from the body.

54. Waste products indicate an inefficient digestive system.

55. Feces are eventually eliminated from the body.

56. The whole digestive system is around 27 feet long.

57. Digestion can take between 24 and 72 hours.

58. Digestion time varies between individuals.

59. Digestion time depends upon the type of food and size of the meal.

60. Doctors are able to use special instruments, like endoscopes, to learn about digestion

61. Endoscopes are long tubes with lenses/cameras used to study the upper part of the digestive tract.

62. Much about the human digestion is still unknown.

C.2.4   Exit Questionnaire Answer Key – Part II

6) **shallow, local –** The enzyme amylase is responsible for breaking down what type of nutrients in food?   *B. Starches*

7) **deep, local** – Which type of food would begin breaking down chemically first in the mouth?   *D. Starchy cracker*

8) **shallow, global** – Identify one organ that is part of the digestive process but is not part of the digestive tract. *brain/nose/eyes/tongue/teeth/liver/pancreas/gallbladder*

9) **deep, global** – What role would sights, smells, sounds, and thoughts of food have for digestion? *To stimulate hunger/motivate someone to eat*

10) **deep, local -** When the stomach muscles are not continually holding a contraction, the size of the stomach is _____. Circle the correct answer.   *B. larger*

11) **shallow, local –** Rugae are *wrinkles/ folds* in the lining of the stomach.

12) **deep, global** – Why would it be evolutionarily advantageous to taste different flavors in food? Circle all correct answers.   *A. To identify nutritious foods, C. To identify poisonous foods*

13) **shallow, global** – The tongue has two roles in digestion. One is a mechanical function and the other is chemical/sensory. What are the two roles of the tongue?

- *Mechanical: move food/shape into a ball or bolus/hold food between teeth (any of the 3 options)*
- *Chemical/sensory: taste food*

14) **deep, local** – Which analogy would be the most appropriate? The liver is like a

_____ for the digestive system. Circle one answer.   *A. sieve*

15) **shallow, local** – True or false: The liver produces chime.   *False*

16) **deep, global** – Serotonin is a neurotransmitter that contributes to feeling of

contentment and happiness. What would reasons why this neurotransmitter be

released when the stomach is full? Circle all correct answers.

C. To motivate eating certain foods, D. To signal when to stop eating

17) **shallow, global** – True or false: Hydrochloric acid's primary role in the stomach is to

break down food in the stomach.   *False*

18) **shallow, global** – Order the following items from fastest to slowest to empty from the

stomach: proteins, starches, fats, liquids *liquids-starches-proteins-fats*

19) **deep, global –** Villi in the small intestine increase the surface area. Why is it so

important for the small intestine to have a large surface area?   *Larger surface*

area allows for greater/more efficient absorption of nutrients.

20) **shallow, local –** The large intestine contains many _____, which contribute to the

fermentation process.   *bacteria*

21) **deep, local –** Why are bacteria important for digestion? *Bacteria digest otherwise*

indigestible material.

22) **deep, local –** True or false: Flatulence, or gas, is one possible effect from eating

indigestible ingredients.   *True*

23) **shallow, local** – What gases are found in the gut? Circle all that correct answers.

B. hydrogen

24) **shallow, global -** What is the main lubricant for the digestive system?   *Mucus*

25) **deep, global** – The adult digestive tract is about 27 feet long. Why does it need to be

this long?   *To absorb more nutrients*

26) **shallow, local** – _____ fibers are an example of an indigestible component of food

that becomes a waste product.   *Cellulose/dietary*

27) **deep, local** – We know that the digestive process is _____ because of the indigestible

material that is eliminated from the body as feces. Circle one answer.   *A. inefficient*

28) **shallow, local** – What are endoscopes?   *An instrument doctors use to study*

the digestive tract

29) **deep, local** – True or false: Endoscopes can be used to diagnose hormonal imbalances

that affect digestion.   *False*

30) **shallow, global** – True or false: Human digestion is well-understood.   *False*

REFERENCES

About us. (n.d.). In Udacity. Retrieved from https://www.udacity.com/us.

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology*, *94*(3) 545-561.

Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations still improve students' learning from text. *Educational Psychology Review*, *14*(1), 5-26.

Educause. (2013). *Learning and the Massive Open Online Course: A Report on the ELI Focus Session* (ELI Paper 2). Washington, DC: Author.

Garner, R., Alexander, P.A., Gillingham, M.G., Kulikowich, J.M., & Brown, R. (1991). Interest and learning from text. *American Educational Research Journal*, *28*(3), 643-659.

Harp, S.F., & Maslich, A.A. (2005). The consequences of including seductive details during lecture. *Teaching of Psychology*, *32*(2), 100-103.

Harp, S. F., & Mayer, R.E. (1997). The role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology*, *89* (1), 92-102.

Harp, S.F., & Mayer, R.E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology*, *90*(3), 414-434.

Hidi, S., & Renninger, K.A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111-127.

Krapp, A. (1999). Interest, motivation and learning: An education-psychological

    perspective. *European Journal of Psychology of Education*, *14*(1), 23-40.

Lehman, S., & Schraw, G. (2002). Effects of coherence and relevance on shallow and

    deep text processing. *Journal of Educational Psychology*, *94*(4), 738-750.

Lehman, S., Schraw, G., McCrudden, M.T., & Hartley, K. (2007). Processing and recall

    of seductive details in scientific text. *Contemporary Educational Psychology*, *32*,

    569-587.

Magner, U. I., Schwonke, R., Aleven, V., Popescu, O., & Renkl, A. (2014). Triggering

    situational interest by decorative illustrations both fosters and hinders learning in

    computer-based learning environments. *Learning and Instruction*, *29*, 141-152.

Mayer, R. E., Griffith, E., Jurkowitz, I.T.N., & Rothman, D. (2008). Increased

    interestingness of extraneous details in a multimedia science presentation leads to

    decreased learning. *Journal of Educational Psychology: Applied, 13*(3), 329-339.

Mazer, J. (2013). Student Emotional and cognitive interest as mediators of teacher

    communication behaviors and student engagement: An examination of direct and

    interaction effects. *Communication Education*, *62*(3), 253-277.

National Governors Association. (2011). *Building a Science, Technology, Engineering,*

    and Math Education Agenda: An Update of State Actions. Washington, DC: NGA

    Center for Best Practices.

Norman, D. (2013, October). MOOCs and Online Education. Seminar presented at the

    Georgia Institute of Technology GVU Brown Bag, Atlanta, GA.

Ozdemir, D. (2009). *The effects of context-dependency of seductive details on recall and*

    transfer in a multimedia learning environment. (Doctoral dissertation). Retrieved

from Virginia Tech Digital Library and Archives. (06042009-092618)

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions.* New York: Oxford University Press.

Panksepp, J. (2003). At the interface of the affective, behavioral, and cognitive neurosciences: Decoding the emotional feelings of the brain. *Brain and Cognition*, *52*, 4-14.

Park, B., Moreno, R., Seufert, T., & Brünken, R. (2011). Does cognitive load moderate the seductive details effect? A multimedia study. *Computers in Human Behavior*, *27*, 5-10.

Rey, G.D. (2012). A review of research and a meta-analysis of the seductive detail effect. *Educational Research Review*, *7*(3), 216-237.

Rowland-Bryant, E.K. (2010). *An examination of potential mediating factors on the seductive details effect in learning from text*. (Doctoral dissertation). Retrieved from TRACE: Tennessee Research and Creative Exchange. (780)

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, *26*(3-4), 299-323.

Schraw, G., Bruning, R., & Svoboda, C. (1995). Sources of situation interest. *Journal of Reading Behavior, 27*(1), 1-17.

Sun, J.C., & Rueda, R. (2012). Situational interest, computer self-efficacy and self-regulation: Their impact on student engagement in distance education. *British Journal of Educational Technology*, *43*(2), 191-204.

Tulving, E. (1967). The effects of presentation and recall of material in free-recall learning. *Journal of Verbal Learning and Verbal Behavior*, *6*, 175-184.

Tversky, B. (1973). Encoding processes in recognition and recall. *Cognitive*

Psychology, *5*(3), 275-287.