THE EFFECT OF REPETITION ON LEARNING AND RETENTION: AN EXPERIMENTAL STUDY ABOUT LEARNING FROM VIDEO

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2024

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Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Educational Sciences

by

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Boğaziçi University

2024

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January 2024

DECLARATION OF ORIGINALITY

I, Dilara Leventoğlu, certify that

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ABSTRACT

The Effect of Repetition on Learning and Retention: An Experimental Study About Learning from Video

This thesis investigates the effects of repetition on learning and retention through an experimental study focusing on educational videos. It examines how repeated exposure to video content impacts students' acquisition and retention of knowledge, guided by theories of meaningful learning and memory models. The study is significant for identifying effective learning strategies, especially with the increasing use of educational videos. By employing an experimental design, the research aims to address gaps in existing literature regarding the efficacy of repetitive viewing and contribute to educational practices by providing insights into optimizing learning and retention through repetition. The study found that repetitive watching of educational videos significantly increased test scores, with participants scoring higher after repetitive viewing (M=3.56, SD=1.19) compared to single viewing (M=2.91, SD=1.28), demonstrating a statistically significant mean increase. For future research, it suggests exploring the effects of repetition with a between-subjects design, measuring comprehension as a learning outcome, using longer and more diverse video lectures, and examining the impact of delayed testing and executive functions on learning and retention.

ÖZET

Tekrarın Öğrenme ve Akılda Tutma Üzerine Etkisi: Video ile Öğrenme Üzerine Deneysel Bir Çalışma

Bu tez, eğitim videolarına odaklanan deneysel bir çalışma aracılığıyla tekrarın öğrenme ve hatırlama üzerindeki etkilerini araştırmaktadır. Video içeriğine birden fazla kere maruz kalmanın öğrencilerin bilgiyi öğrenme ve akılda tutmaları üzerindeki etkilerini, anlamlı öğrenme teorileri ile bellek modelleri ışığında incelemektedir. Özellikle eğitim videolarının giderek artan kullanımıyla birlikte, etkili öğrenme stratejilerinin belirlenmesi açısından çalışma önem taşımaktadır. Deneysel bir tasarım kullanarak, araştırma, tekrarlı izlemenin etkinliği hakkında mevcut literatürdeki boşlukları ele almayı ve tekrar aracılığıyla öğrenme ve hatırlamanın optimizasyonuna dair içgörü sağlayarak eğitim pratiklerine katkıda bulunmayı amaçlamaktadır. Çalışma, eğitim videolarının tekrarlı izlenmesinin test sonuçlarını önemli ölçüde artırdığını bulmuştur; katılımcılar tekrarlı izleme sonrası daha yüksek notlar almışlardır (M=3,56, SD=1,19) tek sefer izlemeye kıyasla (M=2,91, SD=1,28), istatistiksel olarak anlamlı bir ortalama artış göstermiştir. Gelecek araştırmalar için, tekrarın etkilerini özneler arası bir tasarım kullanarak araştırma, öğrenme sonucu olarak kavrayışı ölçme, daha uzun ve çeşitli video derslerini kullanma ve gecikmeli test etmenin ve yönetici işlevlerin öğrenme ve muhafazaya etkisini inceleme önerilmektedir.

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CHAPTER 1

INTRODUCTION

1.1 Background and rationale

We often re-read or re-expose ourselves to the instructional material in order to learn or retain more (Dunlosky et al., 2013; Rawson & Kintsch, 2005) [1]. This maybe the most favorite learning strategy of all time, especially when we are new to a subject (Carrier, 2003; Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Kornell & Bjork, 2007; Miyatsu et al., 2018, Wissman et al., 2012). While the fact that no experimental studies have yet investigated its effect on educational contexts is described as "ironic" (Dunlosky et al., 2013, p.29), a growing number of monographs and books begin to describe this method as low utility or relatively ineffective (Brown et al., 2014; Callender & McDaniel, 2009; Dunlosky et al., 2013; Roediger & Butler, 2011). As such, students are often advised to change this study method with other ones (Brown et al., 2014; Dunlosky et al., 2013).

I became intrigued with the subject when I had a closer look at the relevant literature and started to question underlying reasons and practical implications of such recommendations. To elaborate, these recommendations are usually based on three main reasons (Dunlosky et al., 2013). The first one is the insufficient number of empirical studies. The second one is the mixed/conflicting results yielded by existing research; and the third one is the comparison of rereading with other study techniques (Dunlosky et al., 2013).

[1] Indeed, this strategy is usually referred to as re-reading in the relevant literature because of the long-standing domination of printed learning materials. However, as will be elaborated in the Literature Review section of this proposal, re-reading and re-watching are only different versions of re-exposure. As such, the term repetition or re-exposure is used in this section as an umbrella term.

First, I suppose, declaring a method ineffective based on limited empirical studies thoroughly investigated it would be another irony and that, as people dedicated to bridge the cognitive research with educational practice (Ellefson, 2002), we should instead take this as an invitation to do improve quantity and quality of the related research.

Secondly (concerning the conflicting results yielded by existing evidence), many of the existing studies raises important epistemological and methodological concerns (Mintzes et al., 2011); and such might be reason why they yield to conflicting results (Wiley et al., 2005). For instance, an important critique directed to meta-comprehension research (e.g. Wiley et al., 2005) is that they do not pay enough attention to the text structure and test items (testing memory when in fact aiming to test comprehension is considered a common practice) and I believe this issue is also pervasive in re-reading literature. Indeed, most of the existing literature are not conducted in an educational context (Dunlosky et al. 2013; Rowland, 2014) and/or a predefined framework which differentiate cognitive demands of the task (measurement tool). On the other part, some of the common methodological concerns include lack of control group, neglect of important background variables, inappropriate designs, interference of testing effect, and inadequate statistical power. Indeed, when we systematically review the existing research with some educationally relevant inclusion and exclusion criteria and take some time-honored theoretical distinctions into account (The Literature Review section contains a detailed explanation), I believe the emerging patterns are indeed quite promising in favor of the effectiveness of repetition and they just call for more qualified and nuanced experimental studies grounded on cognitive and educational theories.

Thirdly (concerning the reason based on its comparison with other study techniques), I believe first of all, such methods are not always interchangeable (e.g. it does not make sense to use retrieval practice to improve recall if the student did not comprehend the material in the first place) and that other revision techniques are not free from disadvantages neither (Dunlosky et al., 2013) such as some causing error repetition/persistence, some requiring extensive training, some not being appropriate for all types of learning material or learner characteristics etc.. Finally, not all the studies who directly compares repetition with other methods are methodologically rigorous or fair (e.g. no time equation, repeated testing of only certain groups etc.) and not all the meta-analyses or reviews (e.g. Rowland, 2014) exclude educationally irrelevant materials or types of learning which are known to be cognitively whole different constructs.

Moreover, most of the existing literature referred above deals with printed material (re-reading) and the research about how to learn from educational videos is quite scarce (Schacter & Szupunar, 2015, p.61) presumably because research in this area is focused on other topics such as designing principles and motivation rather than learning strategies. Although general principles of learning from text are applied across modality of presentations (Anderson, 1972; Anderson et al., 2001, Ausubel 2000, Gernsbacher et al., 1990; Noh et al. 2007), and thus results of re-reading studies can be generalized to re-watching practice (e.g. Kiewra et al., 1991; Martin et al. 2018), this literature is also open to progress for reasons outlined above.

1.2 Theoretical framework

1.2.1 Information-processing perspective on learning and memory: A constructivist approach

In broad terms, the proposed research approaches learning and memory from information processing perspective. Such perspective conceptualizes human mind as an information processing system which works by forming mental representations and carrying out cognitive processes (Mayer, 1996, 2013; Shunk, 2012).

Two main versions of information-processing perspective on learning and memory involves the classical/literal and the constructivist approach (Mayer, 1996, 2013). The classic version is tightly based on human-computer metaphor (Mayer, 2013; Shunk, 2012). As such, it views humans as information-processors where information is seen as an objective entity and mental processes as algorithms (Mayer, 2013). The constructivist version, however, mostly utilizes construction metaphor (construction of representations/knowledge/meanings) (Mayer, 1996, 2013). As such, it highlights personal and subjective nature of knowledge (Mayer, 1996, 2013) and control processes (Shunk, 2012) by which humans acquire new meanings.

Since this study is mostly based on information-processing theories which fit into constructivist approach, this section will first provide a brief description of the constructivist perspective and then be followed by specific theories and models which constitute the basis of the study and its hypotheses.

In the constructivist view, learners are active agents who create their own knowledge by integrating what is present at the moment (environmental or mental stimuli) and what they already know (previously constructed knowledge) (Mayer, 1996, 2013). In this view, the content of the mind are mental representations (e.g. words, mental images, knowledge networks etc.) and the activities of the mind are

various types of mental processes such as selecting, organizing, thinking, attending, recalling etc. (Mayer, 2013).

Accordingly, learning is the construction of knowledge (which is also conceptualized as a long-term mental representation) which requires various processes intended to sense making, including selecting environmental stimuli (spoken words, images etc.), organizing experiences (constructing sound/image bases in working memory), and integrating upcoming information with prior knowledge (Mayer, 1996, 2013).

Although there exists many different information-processing theories of learning and memory (even in the constructivist camp) which differ on their views of various phenomenon (e.g. exact nature of mental representations, the importance they attribute to various mental processes, specific depictions of memory etc.), they also have many common tenets (Shunk, 2012), such as general architecture of the cognitive system, active learning and limited capacity assumption (Mayer, 2013). Those common tenets are also shared by the specific theories and models which are bases of this study and which will be explained below.

Beyond the commonality expressed above, it can be said that such base theories and models of the study are mostly cross-referenced or at least highly compatible. To illustrate, although different memory stores will be explained under Atkinson & Shiffrin's memory model (Please see Atkinson & Shiffrin's Multi-Store Memory Model subheading), this idea is, implicitly or explicitly, inherited in the other ones as well. For instance, the notion of active learning, which is the essence of the assimilation theory of meaningful learning and retention (Please see Assimilation Theory of Meaningful Learning and Retention subheading), relies on the communication of different memory stores (working memory and long-term

memory) as depicted by Atkinson & Shiffrin's memory model. The same also holds true for the idea of background knowledge's integration, which is, as per construction-integration model of text comprehension (Please see Construction-Integration Model of Text Comprehension subheading) essential for a complete understanding. Likewise, spreading activation theory of memory (Please see Spreading Activation Theory of Memory subheading) openly refers to such memory stores. Another example of this would be spreading activation theory of factual memory and construction-integration model of text comprehension which both represent knowledge as an associative network. As such, the following theories and models are curated to address different parts or aspects of an inherently wholistic phenomenon (learning and retention) which substantiates in a continuum and/or hyperconnected system.

1.2.1.1 Assimilation theory of meaningful learning and retention

One of the constructivist information-processing theories of learning and memory is Ausubel's assimilation theory of meaningful learning and retention (Mayer, 2013). Several reasons exist for choosing this specific theory as one of the bases of the study and those will be mentioned following the description of the theory's key points and/or where relevant.

Firstly, Ausubel's assimilation theory is a 'cognitive theory of meaningful verbal learning' (Ausubel, 2000). 'Cognitive' here means that it focuses on mental processes of the learner such as assimilation of newly presented material into his/her existing body of knowledge. In other words, it does not focus on other factors (motivational, emotional etc.) which influence learning and retention, although of course it acknowledges them. 'Meaningful' here refers to making sense of the

material by constructing new (and mostly individual) meanings and it stands in opposition to rote learning. In other words, it emphasizes understanding or comprehension component of learning. Finally, 'verbal' indicates type of knowledge to be acquired (i.e. verbal knowledge), of which, subject-matter learning in schooling is a common example (Ausubel, 2000).

The theory also commonly uses the term 'reception meaningful learning'. Reception here refers to a specific type of learning/learning activity where the learner encounters with the principal content of learning in the form of substantive propositions and he/she simply needs to comprehend and remember. In other words, it is the kind of learning activity which parallels expository type of teaching and/or instructional materials (Ausubel, 2000).

It may be important to note here that such four highlights of the theory are not just descriptive but also indicative of its scope. For instance, the theory only deals with learning of the potentially meaningful material (e.g. prose) which may become part of learner's body of knowledge, provided that it is verbal kind of knowledge (Ausubel, 2000). As such, it does not deal with acquisition of other types of knowledge such as procedural or metacognitive knowledge. Similarly, the theory does not apply to other types/activities of learning such as inquiry or discovery learning where the learners should come up with the related propositions by themselves (Ausubel, 2000). In short, it is a cognitive theory of meaningful, verbal and reception learning; with which the study is also interested and bounded.

As such, the first two roles of this theory for the study are also similar, i.e. both descriptive and scope-indicative. To elaborate, Ausubel's assimilation theory both clarifies the meaning of "learning" as approached by this study and limits its scope to exclude other types of learning (e.g. list learning), learning activities (e.g.

discovering), knowledge (e.g. implicit knowledge) etc. In other words, the kind of learning on which this study investigates the effect of repetition is; meaningful, verbal and reception learning as described by Ausubel (2000).

Essentially, this theory views learning as the output of an active process between the learning material and the learner's prior knowledge. In other words, learning occurs in consequence of an active interaction of the instructional material and the learner's relevant ideas in his/her long-term memory (Ausubel, 2000). Since active nature of the learning is at the heart of the theory, it may be important to note that 'activity' in this context is cognitive in so that learner needs to make a cognitive analysis for matching newly presented material with most relevant ideas in his/her long-term memory, to reconcile them by appreciating similarities and discrepancies, to reformulate the material in his/her own words etc. (Ausubel, 2000, p. 82). In other words, the theory still only deals with reception learning (e.g. listening a lecture, reading a textbook chapter, watching an educational video etc.) which would probably not reconcile with more recent conceptualizations of active learning (that usually refer to behavioral kinds of 'activity' such as learning by practicing, problem solving, discussing etc.)

The theory also commonly uses the term 'knowledge acquisition and retention' (usually interchangeably with 'learning'). Firstly, in line with its highlight on active learning, the theory makes clear that word 'acquisition' here does not imply a passive process at all; and that the word in this context is simply used in its general meaning which is 'gaining possession' (Ausubel, 2000, preface). Secondly and importantly for this thesis is that the term retention here underlines that meaningful learning does not end with the initial acquisition of new meanings but also includes memory storage. In this sense, learning is seen as a larger assimilative process which

may or may not result with retention of the related knowledge in long-term memory (Ausubel, 2000).

The issue of retention and memory storage is closely linked with the general architecture of the cognition (also referred to as ‘information processing model of learning and memory’ or ‘multi-store memory model’) as assumed by most of the constructivist information processing theorists. As such, it will be explained in the following heading.

1.2.1.2 Atkinson & Shiffrin's Multi-Store Memory Model

1.2.1.2.1 Overview

As per the general theoretical framework put forward by Atkinson and Shiffrin in their highly influential paper, namely Human Memory: A Proposed System and Its Control Processes (1968), human memory system is classified into i) structural features of the memory which are fixed and permanent (memory structure) and ii) control processes which are varying and dependent upon many factors, such as the control of the subject (control processes).

In this framework, the term ‘memory structure’ encompasses both the physical system and its in-built processes (Atkinson & Shiffrin, 1968). Having said that, unlike the ‘control processes’ which are selected and invoked by the subject, such built-in processes of the memory structure does not change at the will of the subject nor depend on the characteristics of the material, instructions etc. (Atkinson & Shiffrin, 1968).

In line with the purpose of this thesis, this section will mostly focus on permanent and structural characteristics of the memory (basic memory stores and

fixed built-in processes) and control processes will only be mentioned, as needed, in general terms.

The most important distinction made by the framework in relation to memory structure is that it is comprised of different memory stores. Accordingly, fundamental structural components of the memory are i) sensory register, ii) short-term store, and iii) long-term store (Atkinson & Shiffrin, 1968).

In this framework, sensory register is where the incoming sensory information first enters. It remains there for a very limited time period then decays swiftly and lost completely. Short-term store is conceptualized as the subject's working memory which receives selective inputs both from sensory register and long-term store. Short-term store is also limited in terms of the period incoming information can reside, although this is relatively longer when compared with the sensory register. Finally, long-term store is a comparably permanent store for information transmitted from the short-term store (Atkinson & Shiffrin, 1968)

Below, such memory stores will be described a bit more in detail to lay the foundation for a depiction of the information flow across them which is believed to underlie many cognitive functions including learning and retention. Lastly, the depiction of the information flow across the system will be followed by a consideration of the framework's major points in relation to this study and its hypotheses.

1.2.1.2.2 Sensory register

As mentioned before, presented stimulus first enters into the sensory register of the subject (Atkinson & Shiffrin, 1968). It is suggested that this first registration takes places in the relevant sensory dimension of the system, although most of what is

known about the form of this registration concerns visual system. Indeed, characteristics of the visual system which are mostly known due to Sperling's experiments (e.g. 1960) are what guides the framework to identify sensory register as a distinct memory store. While stimulus presented in other modalities are also known to be subject to a first registration, there is little known about them (characteristics, decay time etc.) to also distinguish them as definitive separate memory stores. As for the visual sensory register, it is suggested that visual stimuli leave a photographic like trace of which the decay period is estimated to be several hundred milliseconds. Accordingly, information which is not transferred to the short-term store in this period cannot be recovered from the sensory register thereafter (Atkinson & Shiffrin, 1968)

1.2.1.2.3 Dual stores

Two other major components of the memory structure are i) short-term store and ii) long-term store (Atkinson & Shiffrin, 1968). Reportedly, one important evidence about this distinction, which was debated at the time, came from human patients with acquired memory disorders due to hippocampal surgical lesions (Milner 1959, 1968 as referred in Atkinson & Shiffrin, 1968) The pattern of the disorder which allowed the patient to store new information temporarily (as long as material was appropriate for rehearsal and the process was not interrupted with a distracter task for instance) but disabled him to store new information on a long-term basis (except for new motor skills) has been interpreted as an intact short-term store but a break-down in long-term store and/or its related processes and thus evidence in favor of such dichotomy (Atkinson & Shiffrin, 1968)

1.2.1.2.3.1 Short-Term store

Second component of the system is the short-term store which serves as the working memory of the subject (Atkinson & Shiffrin, 1968, p.90). Indeed, many theories and models which built upon Atkinson and Shiffrin's original framework and further expands it (e.g.Baddeley & Hitch, 1974), as well as the representations of the multi-store memory model for educational purposes (e.g. Furlonge, n.d.; Nolen-Hoeksema et al., 2009) use the term 'working memory' instead of "short-term store" to allegedly highlight its active role in cognitive functions. Having said that, this thesis will stick to the term short-term-store in order to, first and foremost, adhere to the original framework by also acknowledging that, unlike claimed by some (Baddeley, 2010), the short-term-store as conceptualized by Atkinson and Shiffron (1968) was never depicted as having a simple storage role in the first place and it was the original framework itself which explicitly described it as the working memory of the subject. Secondly, representations which use the term "working memory" instead of "short-term-store" also use the term "long-term memory" instead of "long-term-store", presumably for consistence, but this is also problematic, because as will be mentioned in the subsequent paragraphs, such terms (long-term-store and long-term-memory) are not equivalent (Atkinson & Shiffrin, 1968, p.101)

One interesting feature of the short-term-store is that the form of the information which enters herein is not inevitably dependent upon the form of the sensory input. In other words, modality of the information entering/residing in the short-term store do not have to match the modality of the original information as in the case for sensory register. For instance, it is very common for visually presented words to be transferred from the visual sensory register into auditory short-term store for further processes such as rehearsal and output (Atkinson & Shiffrin, 1968)

Indeed, since most of what is known about the short-term store concerns storage in auditory mode (with seemingly inseparable auditory, verbal and linguistic functions of it), the authors explicitly state that, for the purpose of their article, with the term 'short-term-store', they basically refer to the short-term store in auditory-verbal-linguistic (a-v-l) mode, while also remarking that this does not imply the absence of short-term-store in other modalities[2] (Atkinson & Shiffrin, 1968).

Information which enters the short-term-store is also subject to time limit although this is markedly longer when compared with the decay period of the sensory register. Although the exact interval for decay of information in short-term store is difficult to measure due to control processes which may be exercised by the subject (e.g. rehearsal), it is estimated to be around 15 to 30 seconds (Atkinson & Shiffrin, 1968).

1.2.1.2.3.2. Long-Term store

As mentioned, the final principal component of the system is the long-term store, which, as the name suggests, is a relatively permanent store for sustained information (Atkinson & Shiffrin, 1968). In other words, unlike the sensory register and short-term store with time volumes of several milliseconds and 15 to 30 seconds respectively, there is no known time limit for the duration of information in this store. Otherwise stated, although the information which has found its way to long-term store may also be subject to various impairments or retrieval failures, it is suggested that it does not become completely lost the way it get lost from sensory register and short-term store (Atkinson & Shiffrin, 1968).

[2] Although the description of the long-term store and the discussion of this framework in relation to this research proposal will come later, it may be important to note in advance that such restricted usage of the terms also applies to long-term-store (reserved for a-v-l long-term-store) and the terminology used throughout the proposal.

As a reminder, long-term-store under the framework reservedly refers to long-term-store in auditory-verbal-linguistic (a-v-l) mode (Atkinson & Shiffrin, 1968, p.101) However, as in the case for short-term-store (short-term-store for a-v-l short-term-store) this does not imply that information in other modalities cannot be stored in long-term-store. On the contrary, the ability to recognize stimuli in various modalities on long-term-basis is also known. Having said that, since most of the experiments which examined long-term-store deal with a-v-l mode, the characteristics and processes of this store remarked by the framework mostly concerns a-v-l LTS exclusively (Atkinson & Shiffrin, 1968). Importantly, such restricted usage of this terminology also applies to the entirety of this thesis since the kind of learning this study is interested and limited to majorly concerns information-processing in a-v-l mode.

Finally, it should also be noted that the terms short-term store and long-term-store are not equivalents of the short-term-memory and long-term-memory, which in the psychology literature mostly refers to memory studied in short-dated experiments and memory studied in relatively long-dated experiments, respectively (Atkinson & Shiffrin, 1968, p.101). This discrimination with regard to theoretical constructs of the framework (short-term-store and long-term-store) and operational definitions of short-term memory and long-term memory is important because under the Atkinson and Shiffron's memory framework (1968) and this study which builds upon it, both STS and LTS are considered to be at play regardless of the timespan of the experiment.

1.2.1.2.4 Information flow

Flow of information among such stores is what underlies many cognitive processes including learning and retention and is to a great extent under subject's control (Atkinson & Shiffrin, 1968). The framework uses the terms information-flow and transfer usually interchangeably to refer to process of copying information from one store to another. Having said that, it explicitly states that such transfer does not result in the removal of the information from the transferrer store and that the loss of the information from original store is subject to its own decay characteristics. In other words, information from STS for instance does not decay therefrom just because it has been transferred to LTS but is wiped away thereout in line with its own time capacity (Atkinson & Shiffrin, 1968)

According to Atkinson and Shiffrin (1968), the information flow starts with the registration of the stimuli in sensory register.[3] Next, information in the sensory register is very rapidly scanned and a corresponding search is executed in the long-term-store, which are both control processes in so that specificities of this scan and the simultaneous search may vary depending upon many factors. Main purpose of these parallel processes is considered to make a matching of some sort and determine the information which will be transferred to the short-term-store. Selected input is then introduced to the short-term-store. As mentioned before, it is quite common for visually presented words to be transferred from the visual sensory register into short-term store in auditory-verbal-linguistic mode. It is suggested that this is made possible to the search in long-term-store which accompanies the quick scan in the

[3] The framework also acknowledges and explains other types of information flows with different starting points and arriving destinations (e.g. from long-term store to short-term store) but only the one which is important in terms of the proposal is explained here.

sensory register because the semantics of the words for instance are reached and fed into the short-term-store by this means (Atkinson & Shiffrin, 1968).

The fact that only selected information finds its way to the short-term-store (Atkinson & Shiffrin, 1968, p.90, p.94) should be emphasized, especially from the viewpoint of this study, because as will be re-elaborated in the following sections, this means that many information, by the very nature of the human memory system itself, is doomed to get lost, at any single trial, without being subject to any further processing which is desired and necessary for learning and retention.

Another important point about the information flow in terms of the study is that the transfer from the short-term-store to the long-term-store is considered an "unvarying feature of the system" (built-in process of the memory structure) (Atkinson & Shiffrin, 1968, p.103). This means, by extension, that for any information residing in the short-term-store, the transfer to the long-term-store will necessarily take place[4], even though the form and amount of the transferred information is greatly influenced by the control processes which are at the subject's disposal (Atkinson & Shiffrin, 1968, p.103, p.115). This is a major point in terms of the study because it implies that increasing the duration of any information (by way of repetition for instance) in the short-term store is disposed to increase the transfer to the long-term store.

[4] Studies of incidental learning where subjects aim to store the information in short-term-store but end up to also store them in long-term-store, is considered one of the supporting evidences in favor of this automatic transfer.

1.2.1.2.5 Main points reconsidered

To recap the framework's major points which are most relevant to this study and its hypotheses, the first one is that many information which enters the sensory register get lost before finding its way to the short-term store (Atkinson & Shiffrin, 1968, p.90, p.95). In other words, although the capacity of the sensory register is quite large in terms of its volume (the amount of information it can capture), only a very limited part of this can pass into short-term store. As such, it is the extended assumption of this study that repetition might cause more information to enter into short term store because the learner may focus on different parts of the stimuli (words, sentences, meanings) in each time and/or might have a chance to process the information which was previously not attended for various reasons.

The second one is the assumption that information get transferred to the long-term-store as long as it stays in short-term store (Atkinson & Shiffrin, 1968, p.103). In other words, although the form and quantity of this transfer may get influenced by the control processes executed by the learner, the automaticity of this transfer is a fix feature of the memory system (Atkinson & Shiffrin, 1968). Otherwise stated, the traces in the long-term-store gets strengthened throughout the information's stay in the short-term-store. As such, it is the extended assumption of this study that, since repetition and re-exposure lengthens information's total time of stay in the short-term-store, it should, as a result, strengthen the related traces in the long-term-memory, which in broad sense, corresponds to learning and memory. Stated differently, since re-exposure of the material means in some way doubling or at least increasing the information length of stay in short-term-memory, this means the transfer to the long-term-store will also increase somehow, which in broad sense, corresponds to consolidation of the related information.

The last point is indeed a point which is explicitly made by the framework about one of the mechanisms through which rehearsal[5] strengthens long-term-storage (Atkinson & Shiffrin, 1968). To elaborate, it is claimed by the framework that rehearsal strategy, which is actually a control process aiming to store the information temporarily, sometimes results in also storing the related information in the long-term-store, aka incidental learning, through at least two mechanisms (Atkinson & Shiffrin, 1968, p.111). One of them is by way of increasing total length of stay in short-term-store, which is explained above, and the other one is by way of 'saving time' for control processes which qualifies the transfer to the long-term-store (Atkinson & Shiffrin, 1968, p.111). As mentioned, although this point is expressly made about the rehearsal within the scope of the framework, it is the assumption of this study that this should also be the case for the re-exposure to the learning material (re-reading, re-watching etc.) since both of their core nature is repetition. For instance, it is known that elaboration[6] is an important cognitive strategy for learning because it allows the learner to make connections between what she/he already knows (residing in long-term store) and what is she/he is about to learn (active short-term memory) (Brown et al., 2014). Having said that, that usually takes time (even when automatic and takes milliseconds) and a trade-off is usually going on because it inevitably lead the learner to not to attend to new stimuli which continues to flow (e.g. the new information which enters the sensory register cannot enter to the short-term store which is limited in terms of capacity and which is currently engaged in

[5] The framework conceptualizes rehearsal as a control process (selected and invoked by the subject) taking place in short-term-store in order to lengthen duration of some information in the short-term-memory (e.g. self-repetition of a telephone number to be used soon) without necessarily aiming to store it in the long-term-store (Atkinson & Shiffrin, 1968, p.111).

[6] It might be important to note here that although elaboration is usually used in a way to refer to circumstances where the learner makes a conscious effort, it can also happen automatically (e.g. when the lecturer introduces a concept and the learner automatically thinks of an example of such concept without making a conscious effort to do so)

making connections with long-term store). As such, another line of thought which underlies this study is that re-exposure to the learning material may qualify transfer to the long-term store, by way of allowing time for control processes aimed at long-term-storage to take place.

1.2.1.3 Spreading activation theory of memory

Firstly, contrary to what is claimed by some (e.g. Shunk, 2012, Chapter 5), this theory is not an alternative to the multi-store memory model presented above. Indeed, as mentioned before, it builds upon the premises of such, such as acknowledgement of different memory structures (short-term store and long-term store) and their interrelations (e.g. encoding as transformation of a temporal working memory trace into a long-term memory trace). Importantly for this study and differently from most of the theories and models of memory, this theory focuses on explaining retrieval process which affect factual memory performance.

Another note about the theory is that it is indeed much more detailed and comprehensive (e.g. which also aims to make some predictions about various memory-related phenomenon) than will be described below. In other words, only its key points -which are relevant to this study- and the way it gives direction to the hypotheses will be explained briefly.

Essentially, spreading activation theory of factual memory represents knowledge as a mental network (Anderson, 1983). This network consists of cognitive units where encoded and to-be-recalled information is registered. Such cognitive units consist of a unit node (e.g. proposition itself) and some associated elements (e.g. arguments of the proposition). Accordingly, all memorial processes (encoding, storage, retrieval) are realized through such cognitive units (Anderson, 1983).

As per ACT, retrieval processes are what underlies memory performance (Anderson, 1983). Relatedly, retrieval is realized through a spreading activation in the network which represents knowledge. This long-term memory network can get activated from an internal (a thought, an internal computation etc.) and/or an external stimulus (a question, a task etc.) which may enter to the working memory through perception and attention. Activation level of the related network is what determines memory performance. In other words, the higher the related network is activated, the higher the probability and the rate of recall would be (Anderson, 1983).

One of the important factors which affect the activation level, and thus recall is, strength of the individual cognitive units which are involved in the knowledge network (Anderson, 1983). In this context, repetition increases probability of recall by way of strengthening cognitive units and increasing activation potentiality of the related network. To elaborate, repetition strengthens relevant cognitive units/traces, which in turn, increases activation levels/potential of the related network, which in turn increases recall probability and performance (Anderson, 1983). Thereby, ACT foresees that that overlearning, including back to back repetitions, would increase recall probability (Anderson, 1983, pp.262-263).

As per ACT, another important factor which affects the activation level, and thus recall, is the source of activation available at the time of the recall (Anderson, 1983). In other words, the higher the number and directness of activation sources, the higher probability of recall would be. As such, ACT stipulates that recognition is commonly better when compared to recall, because of quality and quantity of activation sources (Anderson, 1983).

1.2.1.4 Construction-Integration Model of text comprehension

As mentioned before, the kind of learning in which this study is interested is meaningful, verbal and reception learning. As highlighted by Ausubel (2000) and many (e.g. Anderson et al., 2001; Kintsch, 1994; Smith, 1983), comprehension is a crucial element of this kind of learning. Similarly, texts are an important avenue for it (Ausubel, 2000, Callender & McDaniel, 2009; Wiley et al., 2005; Wiley et al., 2007). While Ausubel's assimilation theory is one of the first theories which intricately deals with this kind of learning, reveals its active nature, provides important hints for ameliorating it etc.; it does not provide explanations as to how a learner comes to comprehend and remember the content of a text, beyond highlighting the roles of prior knowledge and cognitive activity, and exemplifying some related processes. As such, construction-integration model of discourse comprehension which sets out to explain the underlying processes of text comprehension and memory has been drawn upon for the purposes of this study. Another advantage of the model for this study is that it applies to both reading and listening comprehension (Kintsch & Dijk, 1978, p. 364) since the learning material which will is used in this study is in video format.

As with the other theories and models explained in this section, this theory is also more far-reaching and elaborative than will be mentioned below. In other words, the following description will be brief and partial; and focus majorly on the theory's key points which are most relevant to this study.

Construction-integration model of text comprehension maintains that in order to fully comprehend a text, the reader must go through various phases and construct multiple representations (Kintsch & Dijk, 1978; Kintsch, 1988; Kintsch, 1998). As mentioned before, conceptualizing the content of the mind as mental representations

is at the heart of the constructive information processing approach and this is also the case for this model.

As per CI model (Kintsch & Dijk, 1978; Kintsch, 1988) the first phase of text comprehension involves decoding of linguistic input through lexical access (retrieving meaning of the words based on mental lexicon) and results in surface level (verbatim) representation (Kintsch, 1978; Millis et al., 1998). The second phase involves conceptual analysis of in-text propositions and results in text-level representation. This stage requires semantic access (retrieving meanings of the propositions explicitly stated in the text) and propositional assembly (integration and organization of the related propositions) (Kintsch, 1986). Finally, the third phase involves integration of the reader's background knowledge with text information through various mechanisms such as inference making; and results in situation-level representation (Kintsch, 1986) As per the model, all such phases and representations (surface-level, text-level, situation level) must be complete to have an adequate understanding of and memory for the text (Kintsch & Dijk, 1978; Kintsch, 1986, 1988, 1994, 1998).

According to Kintsch and Dijk (1978), such phases are partly simultaneous and partly sequential, and they don't strain the resources of the system although they are subject to working memory's limitations (p.364). In other words, limited capacity of the system is an important determinant of this process and this is especially critical for memory making (creating new knowledge networks in long-term memory) and response production (e.g. in recall tasks) (Kintsch & Dijk, 1978; p.364).

Importantly for this study, one position (e.g. Amlund et al., 1986; Millis et al., 1998; Stine-Morrow et al., 2004; Rawson et al., 2000) states that these phases are not

only constrained by limited capacity of the working memory but also by each other[7]. In other words, these processes are often hierarchical (not simultaneous) and competitive (Stine-Morrow et al., 2004). As such, the output of a phase becomes the input for another phase (Millis et al., 1998). For instance, construction of a situation-level representation necessitates pre-constructed text-level representation and so on.

Relatedly and importantly for this study, it is claimed that subsequent readings of the same text (or by extension repetitive watching of the same video) may be serving as an opportunity to allocate cognitive resources which are relatively freed up because lower levels of representations were already constructed during the initial reading (Millis et al., 1998; Stine-Morrow et al., 2004; Rawson et al., 2000). In other words, the reader (learner) may allocate a limited amount of cognitive resource at any reading (or watching by extension) attempt and this would usually not enough to construct all the representations simultaneously (Rawson et al., 2000). As such, repetitive presentations may help the learner to come up with a more thorough understanding and memory of the text by working up on his/her incomplete representations (Millis et al., 1998; Stine-Morrow et al., 2004).

1.2.2 A framework for Measurement: Bloom's taxonomy of educational objectives

The general framework upon which measurements of the proposed research will be structured is Bloom's Taxonomy of Educational Objectives -revised- (Anderson et al, 2001). One of the reasons to choose this framework for measurement is its compatibility with the constructive information processing approach to learning and memory in general (Anderson et al, 2001, p.65), and also with the fundamental theories and models of the proposed research in particular, while having an

[7] Indeed, such processes are also referred to as 'mutually constraining' in the relatively later articles of Kintsch and Dijk as well (1988).

educational focus. For instance, distinction between remembering and understanding (as well as the distinction between recognition and recalling as forms of remembering) was obviously not initially made by this framework. Still so, this one has an educational focus and expertise and is also clear enough to guide the assessment questions.

Since not all the elements of such framework will be of interest, a general and brief description of the taxonomy will be followed by elaboration of its key points which are most relevant for the proposed study.

Bloom's revised framework (Anderson et al., 2001) puts the educational objectives into a taxonomy with two basic dimensions. The first one is the knowledge dimension with the following categories: i) factual knowledge, ii) conceptual knowledge, iii) procedural knowledge and iv) meta-cognitive knowledge (Anderson et al., 2001). The second one is the cognitive process dimension with the main categories of i) remember, ii) understand, iii) apply, iv) analyze, v) evaluate, and vi) create (Anderson et al., 2001, p.28). This framework is usually depicted in a table with two dimensions, and the educational objectives can be placed into the cells of the table where the relevant knowledge and cognitive process dimensions intersect.

Table 1. Taxonomy

knowledge dimension	cognitive process dimension					
	1. remember*	2. understand*	3. apply	4. analyze	5. evaluate	6. create
a. factual knowledge*						
b. conceptual knowledge*						
c. procedural knowledge						
d. metacognitive knowledge						

*knowledge and cognitive process categories related to the proposal.
Source: Anderson et al., 2001, p.28

In terms of knowledge dimension, the learning material which will be used in this study and the assessment thereof will correspond to factual and conceptual knowledge of this framework. As such, those terms are very briefly explained below.

Factual knowledge includes knowledge of terminology as well as knowledge of specific details and elements, which together forms the basic elements that a student must know in a certain discipline (Anderson et al., 2001, p.45). Conceptual knowledge, which is another major type of knowledge, involves interrelations of the basic elements, such as knowledge of classifications and categories, and the broader structure of the field, such as knowledge of principles and generalizations or knowledge of theories and models (Anderson et al., 2001, p.48). As mentioned

before, the learning material which will be used in this study involves factual and conceptual knowledge and the criterial tests will assess the acquisition of such types of knowledge. Having said that, in line with the aim of the study, the distinction between factual and conceptual knowledge will not be of interest.

The classification of cognitive process dimension, however, is a keystone for this study and the distinction between remembering and understanding categories, as well as the distinction between recognition and recalling subcategories of remembering will form the basis of measurement and assessment. As such, those are explained in the following.

The framework defines remembering as "retrieving relevant knowledge from long-term memory" and posits recognizing and recalling as the associated cognitive processes (Anderson et al., 2001, p.66). Accordingly, recognition requires the student to search for his/her long-term memory in order to identify whether the presented material corresponds to what she/he has previously learned (Anderson et al., 2001, p.69). Recalling however requires student to retrieve the relevant knowledge from long-term memory and bring it to working memory without being presented with the target information (Anderson et al., 2001, p.69).

Assessment formats for recognition and recall are also distinctive (Anderson et al., 2001, pp. 69-70. Three major methods for assessing recognition are i) verification (True-False format being the most popular), ii) matching and iii) force-choice (multiple choice being the most common format) tasks (Anderson et al., 2001, p.69). Assessments tasks for recalling, on the other hand, highly differ on the quantity and quality of the cues the students are provided with (low cueing and high cueing) but their format is usually short-answer/constructed-responses or fill-in the blanks tasks (Anderson et al., 2001, p.70).

Understanding, which is the second major type of cognitive dimension is defined as constructing meaning from the instructional messages (Anderson et al., 2001, p.70). Such messages can come from written, oral or graphic communications and students may encounter with in books, lectures or computers (Anderson et al., 2001, p.70). Another description given by the framework for understanding is the student's integration of the related knowledge into his/her existing schemas or frameworks (Anderson et al., 2001, p.70).

Cognitive processes for understanding are listed as i) interpreting (being able to change the representational form of the content, such as paraphrasing), ii) exemplifying (which require student to identify crucial aspects of a concept and constructing new examples based on such features), iii) classifying (being able to determine that a certain example fits into a certain concept for instance), iv) summarizing (which requires students to abstract the general theme, to identify the gist or major points of certain body of information), v) inferring (drawing logical conclusions/gathering principles/detecting patterns from the material/based on provided examples), vi) comparing (to determine similarities and discrepancies, matching or contrasting multiple ideas, events etc.) and vii) explaining (constructing a model such as formulating a cause and effect relationship) (Anderson et al., 2001, p.68, pp.70-76).

As for the assessment format, although it may also be possible to use other formats such as selected response under certain conditions, the assessment of comprehension usually requires students to construct a response (supply an answer by themselves) which is commonly known as short-answer, constructed-responses or essay-type formats (Anderson et al., 2001, pp.70-76)

1.3 Significance of the study

Determining optimum learning strategies to be used during self-regulated studies of the students is important for enhancing educational outcomes (Dunlosky et al., 2013). Repetition is one of favorite learning strategies of the students (Carrier, 2003; Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Kornell & Bjork, 2007; Miyatsu et al., 2018, Wissman et al., 2012) and the literature about the effectiveness of such is not yet settled (Callender & McDaniel, 2009; Dunlosky et al., 2013). In other words, the question of whether the revision technique most relied upon by the students is a good one is theoretically controversial and empirically undetermined.

Additionally, learning from expository text (irrespective of modality of presentation) is at the heart of the educational practice (Ausubel, 2000; Wiley et al., 2005; Wiley et al., 2007) in so that expository teaching materials (such as articles, book chapters, structured lectures, instructional videos, talks based on scripts etc.) are still the major avenue of learning, especially in social studies and science instruction (Wiley et al., 2005, p. 409).

Finally, the role and importance of educational videos in both formal and informal education continues to grow (Bétrancourta & Benetos, 2018; Brame, 2016; Fiorella & Mayer, 2018; Guo et al., 2014; Mayer, 2001; Ray, 2012; Sherer & Shea, 2011).

As such, the question of whether repetitive watching of an educational video enhances learning and retention has both theoretical and practical importance for many stakeholders in the ecosystem of education and thus the society.

In this context, this study aims to contribute to the gap in our knowledge about the effectiveness of repetitive watching of an educational video for learning and retention purposes.

1.4 Purpose of the study

One of the aims of education is to help people learn and retain knowledge (Ausubel, 2000). Although mastering a subject or gaining factual knowledge are not the only or ultimate goals of education (Dunloskly et al., 2013), it is accepted by many scholars that it is usually a prerequisite for achieving other instructional objectives such as transfer of learning (Bransford et al., 2000) and application of knowledge (Dunloskly et al., 2013). Afterall, "without an adequate level of initial learning, transfer cannot be expected" (Bransford et al., 2000, p. 53).

Having said that, it is an upsettingly common phenomenon that students do not to achieve cognitive learning objectives (Willingham, 2009). A part of the solution includes helping students to better regulate their learning (Ambrose et al., 2010; Dunloskly et al., 2013, p. 4; Bjork et al., 2013). This involves, among others, knowing which learning techniques have the potential to maximize learning and retention (Bjork et al., 2013; Ellefson, 2019) and ensuring that such information finds its way to classrooms and lifelong learning endeavors (Dunlosky, 2020; Willingham, 2009).

Although there has been a considerable amount of research conducted by educational and cognitive psychologists on the effectiveness on different learning techniques (Dunloskly et al., 2013; Ellefson, 2019); a consensus about the effectiveness of certain techniques is not yet established (Callender & McDaniel, 2009; Dunloskly et al., 2013). Especially important for the purpose of this study has been the unsettlement about the effectiveness of repetition on learning and knowledge retention, as elaborated in various sections of this thesis.

Moreover, most of related existing research are conducted by cognitive psychologists (Ellefson, 2019) and many of them do not parallel the conditions of

educational contexts (Dunlosky et al., 2013) or focus on tasks that are less relevant for educational purposes (Donovan & Radosevich, 1999). The purpose of this study however is education specific. As such, it investigates the effects of repetition on meaningful verbal learning (as conceptualized by Ausubel, 1999) by using authentic educational material and educationally relevant assessments.

Moreover, many of the existing studies which have indeed investigated such questions in educational contexts did not adhere to stringent principles of experimental design. Reportedly:

> "Given that rereading is the study technique that students most commonly report using, it is perhaps ironic that no experimental research has assessed its impact on learning in educational contexts" (Dunlosky et al., 2013, p. 29).

As such, one of major purposes of this study is to enlarge our understanding as to how people gain factual knowledge within educational contexts. A related one is to do so by i) utilizing experimental design, ii) maximizing ecological validity as much as possible, iii) trying to address various methodological problems observed in the current literature (as elaborated and exemplified in different sections of this thesis including the Literature Review) and iv) incorporating cognitive theories of learning and memory with educational approaches to measurement and assessment to have a more wholistic approach to the phenomenon of investigation.

1.5 Research question and hypothesis

RQ: Does repetitive watching of a video lecture led to better learning of the lecture content?

HA: Participants' test scores will be higher after the repetitive watching condition as opposed to the single watching condition.

CHAPTER 2

LITERATURE REVIEW (EMPIRICAL STUDIES)

To overview what has been already done about the research topic, a systematic literature review was conducted on previous studies. Since the related literature is quite large in extent, some criteria for excluding irrelevant articles were set at the beginning of the process. These criteria are as follows:

i. Literature based on studies in which experimental research methods were used.

ii. It is important to note again that the research topic of this thesis study is primarily bounded by an educationally relevant, potentially meaningful verbal material (as defined by Ausubel, 2000; and explained in the theoretical frameworks section of this proposal). As such, studies which used other stimuli such as serial lists, paired associates, vocabulary words, narratives, sole statements (without the original text) etc. were excluded from this literature review.

iii. Research questions of this study are concerned with learning and retention (remembering and comprehending). As such, studies which investigated the effect of repetition/re-exposure on other constructs/dependent variables (such as the effect of re-reading on fluency) are out of scope, unless they also included learning and/or memory related constructs and reported them anyway.

iv. The main inquiry of this study is the comparison of single versus multiple representation. Therefore, studies which did not manipulated number of representations or did not include single presentation condition (read-once; watched-once or listened-once) are out of scope.

v. The experiment which will be conducted for the study will apply multiple representations in a massed fashion (participants in the W2 group will re-watch the videos consecutively/in a single experimental session). As such, studies which exclusively included distributed re-exposure condition are out of coverage on the grounds that massed and distributed study are known to effect learning and retention differently (Durgunoğlu et al., 1993; Krug et al., 1990; Rawson, 2012; Rawson & Kintsch, 2005; Verkoeijen et al., 2008).

vi. The experiment which will be conducted for this thesis will employ immediate tests. As such, empirical studies which administered immediate tests are privileged in the review although the studies which only used delayed tests are also included for perspective.

vii. In terms of coverage, it may be important to note that although the study will use video lecture as learning/instruction material, previous studies which used written (texts) or oral materials (audios) are also covered if they meet the above-mentioned criteria. One reason for this is because general principles of learning from text are thought to be applied across modality of presentations (Anderson, 1972; Anderson et al., 2001, Ausubel 2000, Gernsbacher et al., 1990; Noh et al. 2007). In other words, although there might be some differences, in terms of learner control for instance, those are not thought to effect major cognitive processes which underlie comprehension and remembering. As such, most of such studies (re-reading, re-listening and re-watching) acknowledge each other as previous work and build upon each other (e.g. Kiewra et al., 1991; Martin et al. 2018). The same was done for the current literature review also because there were only three experimental studies which used video lectures and met the above-mentioned inclusion criteria.

Final issue which requires consideration is the specific types of experimental designs used in the previous research. I believe post-test only comparison group designs are the best for addressing such research questions and eliminating internal validity threats which may be caused by testing effect (Campbell, 1957; Cohen et al., 2018; Gay et al., 2012, Roediger & Karpicke, 2006). Having said that, studies which used pre-tests are also covered but notes thereof are made where relevant. Similarly, the studies which applied repeated measure design with the same material are also covered; but either they are partly reported (such as reporting only the results of the first immediate test when in fact participants were tested on 3 test occasions in total), or notes thereto are made when relevant.

Empirical studies which tested the effect of repetition (re-exposure)[8] and which met the criteria mentioned above were organized and presented in this chapter according to 1) the material they have used; namely i) videos (re-watching studies) ii) texts (re-reading studies) and iii) audios (re-listening studies), 2) according to the results they have yielded in overall (whether the effect of repetition is supported by the results or not (full support, partial support and no support) 3) according to the dependent variables they measured (free recall, cued recall, recognition and comprehension).

2.1 Re-watching studies

Re-watching studies can be roughly defined as studies examined the effectiveness of re-watching of the same material as a learning strategy. Such studies are limited in number in the literature though. Specifically, the literature search resulted in only

[8] Since re-reading, re-listening and re-watching are only different versions of repetition, the terms repetition and re-exposure are used in this section as an umbrella term.

three studies which met the inclusion criteria of this literature review explained above. Those are summarized in the following.

The most recent study which used video material have been conducted by Martin et al. (2018). While the researchers were mainly interested on the effect of re-watching on mind wandering, they also measured participants' memory thorough multiple-choice tests covering the facts that were presented in the lecture. The watching condition (watch once and watch twice) was manipulated within participants by using two recorded lectures taken from different courses. Accordingly, memory performance did not significantly differ as a function of the watching condition.

Two other studies that investigated the effect of multiple representation/re-exposure by using video material have also manipulated other conditions such as note-taking (Kiewra et al., 1991) and type of advance organizer (Kiewra et al., 1996) in addition to watching condition.

Kiewra et. al (1991) conducted two experiments to examine the effects of repetition and notetaking on recall. In their first experiment, they used a between-subject design where one group of students watched the lecture once, the second group of students watched it twice and the third group watched it three times. They also manipulated note-taking condition by requiring half of the students in each group to take notes and forbid it for the other half (although they collapsed such conditions when analyzing recall data on the grounds that note-taking treatment did not affect recall). The assessment was made through a free recall task where students were asked to write down as much as they could remember from the lecture. Authors reported that number of presentations strongly affected the total amount of idea units recalled by students.

The design of their second experiment (Kiewra et. al, 1991) was similar to the first one, except that all the students were required to take notes and reviewed them during fifteen minutes before taking the recall test. The authors reported that, in contrast with the first experiment, number of presentations did not affect the overall recall performance. Although it may first seem that the results of such two experiments contradicts as to whether additional presentations aids recall or not, I believe it is quite plausible that the extra time students used for reviewing their notes prevented to see the isolated effect of repeated presentations. In other words, participants in the watch-once condition may have profited from the fifteen minutes review session in such a way that it was no longer possible to single out the effect of presentation conditions.

Kiewra et al. (1996) examined the effects of advance organizers as well as repeating presentations on students' learning through a 3X3 between subject design where they manipulated number of presentations (once, twice and three times) and the type of organizer (linear, matrix or conventional). For the assessment, they used 3 criterial tests in total: a recall test, a relational test and a fact test; and analyzed the results of such separately. Analysis of the fact test indicated a main effect of presentation and the authors concluded that increasing the number of presentations increased factual knowledge of the students. However, neither the main effect of number of presentations nor its interaction with the type of advance organizer was significant for recall and relational tests. Having said that, it may be important to note that similar to the Kiewra et al.'s previous study (1991, experiment 2), participants took the criterial tests after the extra fifteen minutes study session. As such, similar concerns raised thereto may also hold about these results.

2.2 Re-reading studies

As mentioned before, although the study will use video lecture as learning material, previous studies which used written materials (texts) are also covered in the literature review. One reason for this is because general principles of learning from text are thought to be applied across modality of presentations (Anderson, 1972; Anderson et al., 2001, Ausubel 2000, Gernsbacher et al., 1990; Noh et al. 2007). As a result, most of such studies (re-reading, re-listening and re-watching) acknowledge each other as previous work and build upon each other (e.g. Kiewra et al., 1991; Martin et al. 2018) presumably because they are considered as different versions of repetition.

For this reason (and because there were only three experimental studies which used video lectures and met the inclusion criteria stated at the beginning of this chapter), re-reading studies were also reviewed as part of the review of empirical studies.

The most recent re-reading study with the above-mentioned criteria was conducted by Philips et al. (2016). While the focus of the researchers was the effect of re-reading on mind wandering, they also measured participants' comprehension through multiple choice tests covering both the text level and inference level questions. Reading condition (read once and read twice) was manipulated within subjects by using two different texts in each experiment. Reportedly, comprehension scores did not significantly differ as a function of the watching condition in none of the two experiments.

Having said that, I believe the fact that some aspects of the procedure are not justified partly becloud the results of the study. For instance, an introductory text is used to introduce the subject to the participants and to measure their baseline interests before reading of the experimental texts. However, half of the participants

read this introductory text once; while the other half read it two times. However, the reason of such extra manipulation is not explained. Secondly, the reasons why participants took a pre-test and whether such tests had some overlapping questions with the post-test are left unmentioned; which I believe raises concerns about the possible interference of the testing effect (Campell, 1957; Cohen et al., 2018; Gay et al., 2012, Roediger & Karpicke, 2006)

Callender & McDaniel (2009) conducted a study to investigate the effect of re-reading on learning and memory. In four experiments, they used different combinations of five different texts, multiple assessment formats (summary construction, multiple choice, short answer), content specifications (factual or application questions), multiple scoring schemes (scoring summaries by idea unit or macrostructure) and did 19 analyses in total. Only 2 of them indicated re-reading effects.

Having said that I believe some aspects of the study may be considered as problematic. For instance, seven of such analyses concerned an introductory text on social psychology whereas participants were undergraduate students who were recruited by use of the psychology subject pool. Relatedly, the example questions provided in the article seems to be answerable even without reading the related texts.

In 2005, Rawson & Kintsch conducted two experiments to investigate whether re-reading effects depend on time of the test, by manipulating reading condition (read once, read twice in a massed fashion, read twice in a distributed manner) and time of testing (immediate test and delayed test) in a 3X2 between subject design. In the first experiment, researchers used one recall and one comprehension test and analyzed the scores separately by conducting two 3X2 independent ANOVAs for each test. For both the recall and comprehension tests,

both the reading condition and its interaction with the time of testing was significant. Accordingly, for the groups who were tested immediately, performance was higher in the massed re-reading condition when compared to single reading condition; whereas for the groups that took the delayed tests, performance was higher in the distributed re-reading condition when compared to single reading condition. Authors conducted a second experiment to conceptually replicate the first one by using different texts and type of tests. The basic pattern of the first experiment in which massed re-reading outperforming single reading condition in the immediate test and distributed re-reading outperforming single reading condition in the delayed test was also obtained here for both tests.

Rawson (2012) conducted a study where she was mainly interested on testing different theoretical accounts as to why re-reading effect depends on time of the criterial test. In the first experiment, she manipulated reading condition (reading once, short-lag re-reading and long-lag re-reading) and time of testing (immediate and delayed tests) through a 3X2 between-subjects design. She used three recall measures (one free recall test, one intra-sentence cued recall test and inter-sentenced cue recall test) and analyzed the results of such tests separately. Accordingly, free recall performance was higher in both short-lag and long-lag re-reading conditions when compared to single reading condition in both immediate and delayed tests. As for the intra-sentence free recall performance, study groups did not differ from each other when tested immediately; whereas long-lag re-reading group outperformed single reader when tested two days later. Finally, performance on the inter sentence cued recall was not significant among study groups when tested immediately; and only long lag group outperformed single study group when tested two days later.

In 2011, Karpicke and Blunt conducted a study to test the effectiveness of the retrieval practice. Study condition was manipulated between subjects (study-once, repeated study, elaborative concept mapping and retrieval practice) and assessment of the learning was made with a short-answer test covering both factual and inference questions. The test was administered one week after the study session. Of interest for this study, repeated study group outperformed study-once condition for both verbatim and inference questions.

Agarwal et al (2007) conducted a study where they were mainly interested to test the testing effect in different conditions (open-book and close-book tests). Having said that, in the second experiment they also wanted to investigate the effect of re-studying on long-term retention. As such, they also introduced new categories for study condition (read-once, read-twice and read three times), in addition to the ones they used in Experiment 1 (close-book test, close-book test with feedback, open test simultaneous answering, no study). They manipulated study conditions within participants by using seven different texts with a corresponding test for each. The final test took placed one week later after the study session. Of interest for this study, performance was higher in the study-twice and study-three times conditions when compared to study once condition.

Griffin et al. (2008) conducted two experiments to investigate the roles of re-reading, individual differences and self-explanation on meta-comprehension accuracy. Reading condition was manipulated between participants and comprehension was assessed through inference verification tests. Although researchers' focus interest was meta-comprehension accuracy, they also reported that reading conditions did not differ comprehension performance of the groups.

Rawson et al (2000) conducted two experiments to investigate the effect of reading trials on meta-comprehension accuracy. To do so, they randomly assigned the participants to one of the reading conditions (single reading or re-reading). Although their focal interest was meta-comprehension accuracy, they also reported their findings regarding participants' test performances. Accordingly, in the first experiment, test performance of the rereading group was marginally higher than the test performance of the single reading group. However, in the second experiment, test performance of the rereading group was reliably higher than the test performance of the single reading group.

In 2005, Dunlosky and Rawson conducted a study to examine the reasons for why re-reading improves meta-comprehension accuracy and specifically to test the levels of disruption hypothesis. To do so, they randomly assigned participants into three different conditions (single reading group, immediate re-reading group and delayed re-reading group). Although their primary interest was again meta-comprehension accuracy, they also reported test performances of the participants and the analyses thereof for completeness. Reportedly, rereading conditions did not affect test performance, neither when collapsed across the question types, neither when analyzed separately (inferential and memory-based questions).

In 2000, Millis et al. conducted a study to investigate how readers update their situation model across reading trials and specifically to test the situation operator model. In their first experiment, they randomly assigned the participants into one of two study conditions (read-only or read-draw). After the first reading of the text (and after the first reading and drawing by the read-draw group) all participants re-read the material and took the drawing task. Of interest for this study, authors reported that memory increased across reading trials, although it may be

claimed that first drawing task may have served as a practice test and that such results are attributable to the combination of testing and re-reading effects.

In 2001, Millis and King conducted a study to test whether readers process texts in a strategic way and if so, whether that depends on comprehension ability or not. Procedurally, all participants read the passages first, took the drawing assessment, re-read the texts and re-took the same assessments. Of interest for this study, authors reported that memory increased as a function of reading (recall improved across first and second readings) in both experiments. Having said that, similar claims noted above (for Millis et al., 2000) may also hold for such results.

Krug et al., 1990 were interested to investigate the differential effects of massed and distributed re-reading on recall. As such, they formed two main groups reflecting such aim of the study. Massed re-reading group read the text, re-read it and was tested in a single session. Distributed re-reading group, on the other hand, did the initial reading in the first session but re-read and took the test in the second session which took place one week later. The researchers also formed two control groups to mirror the massed re-reading and distributed re-reading conditions. Accordingly, control A group did a single reading and tested one week later; whereas control B condition did a single reading and took the test immediately. Researchers analyzed the data with three orthogonal contrasts (control A vs control B + experimental conditions; control B vs experimental conditions; and massed re-reading vs distributed re-reading) which corresponded to three hypotheses of the study. As such, the researchers did not contrast massed re-reading group with Control B, but only gave the descriptive statistics thereof. Accordingly, massed re-reading group recalled approximately 1.5 times more ideas than the control B group.

Barnett and Seefeldt (1989) conducted a study to investigate the effect of repetitive reading on recall as well as to explore the strategic nature of re-reading. To do so, they told half of the participants that they will read the text once and the other half that they will read it twice (two instruction condition); when actually only half of each instruction groups were allowed to read the text twice (two reading condition). They also divided the participants as high or low ability groups (using a median split with the participants' ACT scores) which resulted in a 2X2X2 between subject design. First section of the test involved short essay questions about factual information stated in the text while second section involved transfer problems (about the novel situations which required the students to apply general principles stated in the text). Authors reported that for factual scores, there was no significant interaction, but the main effect of reading was significant. Accordingly, re-reading group recalled more than the single reading group. For transfer scores however, ability-reading interaction was significant. As reported by the authors, high ability students benefited more from the second reading while a second reading did not improve transfer scores of low ability groups.

Amlund et al. (1986) conducted a study to investigate the effect of repetitive reading on recall. To that aim, they manipulated reading condition by forming three groups (read-once, read-twice, read-three times). All such groups were tested on three occasions (immediate test, immediate re-test and delayed test) with free recall and cued recall measures in each time. Of interest for this study is the comparison of three groups in the immediate test occasion only; because as also admitted by the researchers, read-once group may have profited more from re-contact with the material (p.57) which may have beclouded to see the isolated effects of multiple readings. Accordingly, immediate test performance of read-twice and read-three

times group were significantly higher than the read-once groups for both free and cued recall measures.

Dyer et al. (1979) conducted a study to investigate the effects of re-reading, note taking and summarizing strategies on recall. To that end, they manipulated reading condition (read once and read twice), note taking (notetaking and no notetaking), summarizing (summary and no summary) and time of testing (immediate and delayed) in eight experimental groups. Finally, test items were classified either as substance or verbatim. Reportedly, main effect of reading as well as reading by test item interaction were significant. Although researchers did not reported the results of the simple effects analysis, descriptive statistics (when combined with the abovementioned result) indicates that re-reading group outperformed the single reading group but it is not clear whether this effect is more pronounced for the verbatim questions or substance ones.

In the preliminary study conducted by Rothkopf (1968), students were assigned to read experimental passages in one, two or four times along with a control group who did not read it at all. Recall was assessed ten minutes after the final reading with a cloze test. As reported by the researcher, recall performance increased as a function of reading times, although the acceleration was negative and performance leveled-off after two reading.

2.3 Re-listening studies

Studies which used an audio material and met the criteria explained at the beginning of this chapter are outlined below.

Mayer (1983) conducted a study to investigate the effects of advance organizers and repetition on learning from prose. To that end, he formed four groups

where one group listened the passage once (1X), the second group listened it twice (2X), the third group three times (3X), and the final group was presented with an advance organizer and then listened the audio once (AO). Different sets of analysis were done to compare the effect of repetition (among 1X, 2X and 3X) and the effect of advance organizer (1X and AO). Of interest for this study is the comparison of the 1X, 2X and 3X groups.

Another aim of Mayer's study (1983) was to test quantitative and qualitative hypothesis. Quantitative hypothesis basically states that repetition increase the total amount of recall, but processes are not qualitatively different in the first and additional presentations. Qualitative hypothesis, on the other hand, states that repetition does not only increase the total amount of recall but also causes qualitative differences on learning (such as re-organizing the information or converting them to his/her own words). As such, three tests were administered to the participants. One of them (free recall) aimed to test the quantitative hypothesis and the two others (verbatim recognition and problem solving) the qualitative hypothesis. As per the results of the first experiment, in free recall and problem-solving tasks, group 3X outperformed group 1X and group 2X, which were not significantly different from each other.

In the verbatim recognition task however, group 1X's performance was significantly higher than group 3X. It may be important to note here that such verbatim memory test covered 10 pairs of sentences, one of which was exactly the same as in the original text, and the second was a distractor sentence which included a synonym of one word from the target sentence. In other words, the meanings were the same and the test was exactly constructed to test whether repetition serves the

learner to reorganize the content, which is, taken as an indication of comprehension (Mayer, 1983).

As per the results of the second experiment (Mayer, 1983) which only included free recall tasks, recall performance of group 3X and group 2 X, which were not significantly different from each other, both outperformed group 1X.

In 1986, Bromage and Mayer conducted three experiments in a study with an aim to test quantitative and qualitative effects of repetition. The first experiment used a between-subject design with three different groups (one presentation, two presentation and third presentation). Second experiment used a within subject design where all participants listened the audio three times and were tested after each. Third experiment used a between subject design and was procedurally the same with the first one except that all groups were provided with advance organizers before being presented the material. Authors reported that the number of presentations increased the total recall in the first and second but not in the third experiment; where advance organizers were taught to diminish the need for repetition.

2.4 An overall look at the Repetition/Re-exposure effect (Classification of the research studies based on whether they support the effect of repetition)

So far 21 research paper (3 re-watching, 16 re-reading and 2 re-listening) were summarized. On their overall results, we see that in 11 of them do fully support re-exposure effect. This means, for the studies which conducted more than one experiments and/or more than one analyses, all results thereof are in favor of re-exposure effect. 4 out of 21 studies, does not support the re-exposure effect whatsoever; whereas the remaining 6 studies reported mixed results.

Table 2. Classification of the Related Research based on their Overall Results

Full Support	No Support	Mixed Results
Rawson & Kintsch, 2005	Martin et al., 2018	Kiewra et al., 1991
Karpicke & Blunt, 2011	Philips et al., 2016	Kiewra et al., 1996
Agarwal et al., 2007	Dunlosky & Rawson, 2005	Rawson, 2012
Millis et al., 2000	Griffin et al., 2008	Callender & McDaniel, 2009
Millis & King, 2001		Rawson et al., 2000
Krug et al., 1990		Bromage and Mayer, 1986
Barnett and Seefeldt, 1989		
Amlund et al., 1986		
Dyer et al., 1979		
Rothkopf, 1968)		
Mayer, 1983		

2.5 Classification of the findings based on whether they support the effect of repetition

Majority of those 21 research studies (articles) included more than one experimental study, therefore include more than one finding. Moreover, many of these studies conducted more than one analysis within the same experiment because they measured more than one dependent variable (free recall, comprehension etc.) or for other reasons. Therefore, there were a total number of 58 analyses conducted in such 21 research studies.

Table 1 classified these studies based on their overall results, namely as full sport, no support and partial support. The category of partial support was specifically formed to address the results of the studies which conducted more than one experiments and/or more than one analyses regarding the same experiment.

It may be important to note that such research studies include considerably varying number of total analyses; minimum one, maximum 19. Therefore, a classification of such 58 findings would probably be biased. Nevertheless, Table 2 classifies the findings of such 58 analyses conducted across such 21 research studies, for the sake of completeness.

A table showing classification of the findings based on whether they support the effect of repetition or not is given in Appendix A.

2.6 Differentiating the constructs (Dependent Variables/Learning outcomes)

As mentioned in the Methods Section of this proposal, the proposed study will employ four different criterial tests in total. Those are free recall test, recognition test, cued-recall test and comprehension test. The major distinction here is the cognitive process required by the task (cognitive demand) as distinguished by revised taxonomy of educational objectives (Anderson et al., 2001). Therefore, a final analysis of the previous studies concerned such distinction.

It may be important to note here that such classification of the previous studies is partly independent of how the researchers themselves named the related constructs or assessments. For instance, Kiewra et al. (1996) employed a test which they named as "single-item relational test" where they asked the participants to describe similarities and differences of two methods described in the lecture and they did not explicitly named their dependent variable. Nevertheless, the analysis concerning this test has been classified as comprehension based on Bloom's taxonomy (Anderson et al., 2001, p. 75).

2.6.1 Free recall

Free recall tasks require the learners to recall the material as much as much as they can without providing any clue such as the subtitle of the text or any questions. Out of the 58 analyses conducted by 21 studies, 16 of them used concerned free recall tests. 13 of such 16 had instructions such as “write down/type in everything/as much as you can remember/recall from the passage/text/lecture” etc. and 3 of them were drawing tasks.

Table 3. Results of Free Recall Tests

Study	Experiment/Analysis	Repetition Effect
Kiewra et al., 1991	experiment 1	yes
Kiewra et al., 1991	experiment 2	no
Kiewra et al., 1996	analysis 1	no
Rawson & Kintsch, 2005	experiment 1_analysis 1	yes
Rawson & Kintsch, 2005	experiment 2_analysis 1	yes
Rawson, 2012	experiment 1_analysis 1	yes
Millis et al., 2000		yes
Millis & King, 2001	experiment 1	yes
Millis & King, 2001	experiment 2	yes
Krug et al., 1990	experiment 1	yes
Amlund et al., 1986	analysis 1	yes
Mayer, 1983	exp 1_analysis 1	yes
Mayer, 1983	experiment 2	yes
Bromage & Mayer, 1986	experiment 1	yes
Bromage & Mayer, 1986	experiment 2	yes
Bromage & Mayer, 1986	experiment 3	no

As can be seen in Appendix A, 13 of such 16 analysis reported results which support the effect of repetition on free recall.

Additionally, out of 3 analyses which did not indicated the effect of repetition on free recall, 2 of them (Kiewra et al., 1991, experiment 2 and Kiewra et al., 1996, analysis 1) were the ones which gave fifteen minutes extra study time to all groups, which was previously critiqued for having prevented to see the isolated effect of repeated presentations. Finally, the third analysis (Bromage & Mayer, experiment 3) concerned the design where all groups were presented with an advance organizer to see whether such will diminish the effect of repetition or not.

2.6.2 Recognition

As mentioned in the Theoretical Framework and Method Sections of this Proposal, recognition requires the student to search for his/her long-term memory in order to identify whether the presented material corresponds to what she/he has previously learned (Anderson et al., 2001). Three major methods for assessing recognition is to use verification (True-False format being the most popular), force-choice (multiple choice being the most common format) and matching tasks (Anderson et al., 2001).

Out of the 58 analyses conducted by 21 studies, 10 of them concerned recognition tasks.[10]

[10] Although an analysis of Mayer (1983) concerned a verbatim recognition test (exp 1_analysis 3), such was not included in the Table. The main reason for this is because Mayer aimed to test qualitative hypothesis with a verbatim memory test (which had 10 pairs of sentence, one of which was exactly the same as in the original text, and the second was a distractor sentence which included a synonym of one word from the target sentence) on the grounds that reorganization of the content (keeping the meaning of the words but not distinguishing whether it was the original word or a synonym) was considered as an indication of acquiring the main conceptual framework. In other words, a decrease in verbatim recognition task, in this context, was assessed as an indication of high-level processing.

Table 4. Results of Recognition Tests

Study	Experiment/Analysis	Repetition Effect
Martin et al., 2018		no
Kiewra et al., 1996	analysis 3	yes
Callender & McDaniel, 2009	experiment 1_analysis 1	no
Callender & McDaniel, 2009	experiment 2_text1 _analysis 1	no
Callender & McDaniel, 2009	experiment 2_text2 _analysis 1	yes
Callender & McDaniel, 2009	experiment 3_text 1_analysis 1	no
Callender & McDaniel, 2009	experiment 3_text 2_analysis 1	no
Callender & McDaniel, 2009	experiment 3_text 3_analysis 1	no
Callender & McDaniel, 2009	experiment 4_text 1_analysis 1	no
Callender & McDaniel, 2009	experiment 4_text 2_analysis 1	no
Dunlosky & Rawson, 2005	analysis 2	no

As can be seen in Table 4, 9 out of 11 yielded results which did not support the effect of repetition on recognition.

2.6.3 Cued recall

Recalling requires student to retrieve the relevant knowledge from long-term memory and bring it to working memory without being presented with the target information (Anderson et al., 2001, p.69) and assessments tasks for recalling highly differ on the quantity and quality of the cues the students are provided with (low

cueing and high cueing) but their format is usually short-answer/constructed-responses or fill-in the blanks tasks (Anderson et al., 2001, p.70).

Out of the 58 analyses conducted by 21 studies, 9 of them concerned criterial tests based on cued recall.

Table 5. Results of Cued Recall Tests

Study	Experiment/Analysis	Repetition Effect
Rawson & Kintsch, 2005	experiment 2_analysis 2	yes
Rawson, 2012	experiment 1_analysis 2	no
Rawson, 2012	experiment 1_analysis 3	no
Karpicke & Blunt, 2011	analysis 1	yes
Agarwal et al., 2007	experiment 2	yes
Barnett and Seefeldt, 1989	analysis 1	yes
Amlund et al., 1986	analysis 2	yes
Dyer et al., 1979		yes
Rothkopf 1968		yes

As can be seen in the Table 5, 7 out of 9 supported the effect of massed repetition on cued recall.

2.6.4 Comprehension

As mentioned in the Theoretical Framework Section of this Proposal, understanding (comprehension) is the second major type of cognitive dimension in Bloom's taxonomy and is defined as constructing meaning from the instructional messages (Anderson et al., 2001). Accordingly, such messages can come from written, oral or graphic communications and students may encounter with in books, lectures or

computers. Another description given by the framework for understand is to integration of the related knowledge into his/her existing schemas or frameworks by the student. Cognitive processes for understanding are listed as interpreting, exampling, classifying, summarizing, inferring, comparing and explaining (Anderson et al., 2001)

Out of 58 analyses conducted by 21 studies, 22 of them concerned tests which in some way or another deal with comprehension.

Table 6. Results of Comprehension Tests

Study	Experiment/Analysis	Repetition effect
Kiewra et al., 1996	analysis 2	no
Philips et al., 2016		no
Rawson & Kintsch, 2005	experiment 1_analysis 2	yes
Karpicke & Blunt, 2011	analysis 2	yes
Callender & McDaniel, 2009	experiment 1_analysis 2	no
Callender & McDaniel, 2009	experiment 2_text1 _analysis 2	no
Callender & McDaniel, 2009	experiment 2_text 2_analysis 2	no
Callender & McDaniel, 2009	experiment 3_text 1_analysis 2	no
Callender & McDaniel, 2009	experiment 3_text 1_analysis 3	no
Callender & McDaniel, 2009	experiment 3_text 2_analysis 2	no
Callender & McDaniel, 2009	experiment 3_text 2_analysis 3	yes
Callender & McDaniel, 2009	experiment 3_text 3_analysis 2	no
Callender & McDaniel, 2009	experiment 3_text 3_analysis 3	no
Callender & McDaniel, 2009	experiment 4_text 1_analysis 2	no
Callender & McDaniel, 2009	experiment 4_text 2_analysis 2	no
Griffin et al., 2008	experiment 1	no
Griffin et al., 2008	experiment 2	no
Rawson et al., 2000	experiment 1	no
Rawson et al., 2000	experiment 2	yes
Dunlosky & Rawson, 2005	analysis 1	no
Barnett and Seefeldt, 1989	analysis 2	yes
Mayer, 1983	experiment 1_analysis 2	yes

As can be seen in Table 6, only 6 out of 22 yielded results which support the effect of repetition on comprehension. Having said that, I believe this does not gives a reliable picture for several reasons.

Firstly, it may be important to note that 11 of such 22 analyses were conducted within the same study (Callender & McDaniel, 2009). I believe this means that any general methodological concern regarding this study will probably prevail all the related analyses. For instance, a discussion about whether such experiments had adequate power or not raised by the authors themselves (p.38). A similar issue about such study is that some of the analyses conducted in different experiments are the same in terms of the material use, assessment and scoring (e.g. experiment 1_analysis 2 and experiment 2_text1 _analysis 2). Although it may be argued that such was done in order to test the replicability of the results, I believe the common practice (e.g. Rawson & Kintsch, 2005) to change at least one aspect of the experiment/analysis would be more informative. I believe yet another issue, which was also discussed above (re-reading studies), is the fact that neither participants took any prior knowledge assessment nor a norming study was conducted to investigate whether some of questions were already answerable without encountering with the material. I believe this concern is especially valid for materials such as an introductory text to social psychology (which is one of the main materials of the study) especially since participants were recruited from psychology pool. Finally, I believe the general concern about the possibility to correctly answering some of the comprehension questions strategically based on general backround knowledge and/or with the help of key words (Wiley et al., 2005) is especially prominent for this study, based on the example questions provided by the article.

Secondly, I believe various methodological issues are another reason for not relying on this picture. For instance, some studies which were previously critiqued for beclouding the effect of repetition, if any, with extra study time (Kiewra et al., 1996) or unjustified pretests (Philips et al., 2016) had also comprehension-related analyses.

Thirdly, it is argued by many that testing memory when in fact aiming to test comprehension is quite possible (Anderson, 1972; Anderson et al., 2001, Wiley et al., 2005). For instance, meta-comprehension research has been sometimes critiqued for not paying enough attention to the test items (e.g. Wiley et al., 2005). One position also states that this might also be the reason why results seems conflicting on the surface (e.g. Wiley et al., 2005) In addition to the fact that some of such 22 analyses comes from meta-comprehension literature, I believe this problem is not unique to meta-comprehension research.

Relatedly, when we want to have a closer look on the questions addressed by these tests, we see that most of such studies do not provide an exemplary question and many of them do not specify the nature of such questions (other than stating that it was a comprehension test) or make enough explanation thereof. Yet another group of studies collapse different kinds of questions and yet name the test as comprehension.

For instance, the construct Philips et al. (2016) set out to measure is reportedly comprehension. For one of their text, they constructed a posttest with 18 questions and stated that 6 of such questions were “inference level” and the remaining 12 were “text level”. In their context, text-level questions are defined as questions “based on factual or surface level characteristics of the text” (p. 2343) I believe this is especially problematic since it was previously shown that conditions

which improve memory for text might be different from those which improve comprehension of text (Wiley et al., 2005)

Finally, I believe the intrinsic challenges of assessing the comprehension which are discussed under the Methods Section are also prevalent for some of these studies. To elaborate, the questions with constructed response formats might have led to the interference of retrieval processes. Multiple choice and verification formats on the other hand might have been subject to guessing (none of them reported any correction for guessing)

All in all, I believe the reasons why "evidence concerning the effects of rereading on comprehension is somewhat muddy" (Dunlosky et al., 2013, p. 28) has some epistemological, methodological and practical grounds, as exemplified above for this sample of studies.

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CHAPTER 3

METHOD

3.1 Research approach

Since the study is interested in a causal relationship, it adopted a quantitative approach and was conducted in the form of an experiment (Cohen et al., 2018; Gay et al., 2012, Field & Hole, 2003) which is said to be “science's best defense against alternative explanations for causal claims” (Scholten, n.d.)

3.2 Experimental Design

We implemented a within-subject design where all participants experienced both conditions: i) single watching and ii) repetitive watching. Specifically, each participant first watched the video once and responded to the questions in the first test (Test 1). Immediately afterward, the same participant re-watched the video and responded to a different set of questions in the second test (Test 2). While Test 1 and Test 2 were distinct assessments, they were intentionally designed to be parallel tests.

3.3 Construction of test questions and counterbalancing

Five pair of questions (ten questions in total) were prepared for video 1 (Epistemology). Each pair of questions was intended to have similar item difficulty in order to end up with two equivalent tests (Test 1 which participants took after initial watching of the video and Test 2 participants took after repetitive watching of the video).

Each pair of questions were randomly assigned to either Test 1 (the test participants will take after initial watching of the video) or to Test 2 (the test

participants will take after repetitive watching of the video) through https://www.randomlists.com/team-generator. This ended up in five questions in each test for version A.

For the purposes of counterbalancing, five questions which appeared in Test 1 of version A appeared in Test 2 of version B; and five questions which appeared in Test 2 of version A appeared in Test 1 of version B.

Random assignment of the same pair of questions and counterbalancing was repeated to construct version C and D.

The procedure was repeated for video 2 (Ontology). This resulted in a plan as follows:

Table 7. Versions/Sub-groups

Version/Sub-group	Number of Participants
Epistemology A	8
Epistemology B	8
Epistemology C	8
Epistemology D	8
Ontology A	8
Ontology B	8
Ontology C	8
Ontology D	8
Total	64

Additionally, the order of questions was also shuffled within the same subgroups. Each test contained 5 questions and there were scored out of 5.

3.4 Data collection (Experiment)

The study involved undergraduate students from the Faculty of Education at Boğaziçi University. Participant recruitment was facilitated in collaboration with academic advisors and course instructors, emphasizing the voluntary nature of participation. As a token of appreciation, participants received a gift card valued at 50 ₺ (Turkish Liras) for use at the campus cafeteria. Participants reserved a spot according to their schedule through https://www.wejoinin.com/sheets/xffyh. Data collection commenced on November 16, 2023 and concluded on November 30, 2023.

3.5 Sample size and rationale

To determine the appropriate sample size, we conducted a power analysis using the G*Power software (v.3.1). Our objective was to achieve a power of .95, allowing us to detect a medium effect size of 0.5 at a standard .05 alpha error probability for a one-tailed matched pair t-test. This resulted in 48. Initially targeting a sample size of 48 participants, we opted to recruit 64 individuals to account for potential dropouts and the likelihood that not all recruited participants would complete the entire task.

3.6 Variables

We manipulated watching condition (repetition). The variable had two levels: single watching (no repetition) and repetitive watching (repetition).

Students' learning was our dependent variable. Students' learning was measured with achievement tests with fill-in-the-blank item formats.

Additionally, participants filled out a perception survey. The survey included items that measured participants' perception of i) their prior knowledge about the

content of the video, ii) their interest in the content of the video iii) their English proficiency to understand the video and test items iv) their attention level during the experiment. A pilot study has been conducted to test the test questions beforehand.

3.7 Learning material

We use two videos. Half of the group watched video 1 (Epistemology) and the other half watched video 2 (Ontology). The aim for using more than one video was to make sure that any effect which may come out as a result of the analysis is not restricted to that specific video content. In other words, the purpose of using two different videos was generalizability.

The videos are taken from a course published by University of Amsterdam in Coursera Platform, namely Quantitative Methods. The links and transcripts of the videos are provided in Appendix 6.1.

3.8 Procedure

Each session commenced with a brief description of the study, followed by participants completing the consent form. Subsequently, they viewed the video once and undertook Test 1. Afterward, the video was played a second time, and participants completed Test 2. Finally, they filled out the perception survey, received thanks, and underwent debriefing. Each session had a duration of approximately 20 minutes. There were 1 (minimum) to 6 (maximum) people in one session.

3.9 Pre-registration

We did a pre-registration (osf.io/pgr5m) through Open Science Platform on November 14, 2023 -before starting the data collection. In the pre-registration, we stated our hypothesis, statistical models and inference criteria as follows:

"Participants' test scores will be higher after the repetitive watching condition as opposed to the single watching condition."

"We will use one tailed paired sample t-test to analyse our results. Manipulated, categorical variable will be watching condition (repetition) with single watching and repetitive watching categories; whereas the dependent variable will be learning."

"We will use the standard $p<.05$ criteria in directional hypothesis testing to determine if the paired sample t-test suggests that the results are significantly different from those expected if the null hypothesis were correct."

CHAPTER 4

RESULTS

4.1 Sample characteristics

A total of 64 participants has participated in the experiment. All of them were undergraduate students enrolled in the Faculty of Education of a moderately sized University located in a metropolitan city. Table 8 shows distribution of participants by their departments.

Table 8. Distribution of Participants by Department

Table 8. Frequency and Percent of Participants' Departments

Department	*Frequency*	*Percent*
Primary Education	5	7.8
Mathematics and Science Education	15	23.4
Educational Sciences	20	31.3
Foreign Language Education	24	37.5
Total	64	100.0

4.2 Statistical analysis

Descriptive Statistics

Table 2 provides the descriptive statistics of the test scores across two conditions As shown in Table 9, participants' test scores were higher on average after repetitive watching (M=3.56, SD=1.19) as opposed to single watching (M=2.91, SD=1.28).

Table 9. Descriptive Statistics

Condition	*n*	*Mean*	*Min.*	*Max.*	*Std. Deviation*
Single Watching	64	2.91	0	5.00	1.28
Repetitive Watching	64	3.56	0	5.00	1.19

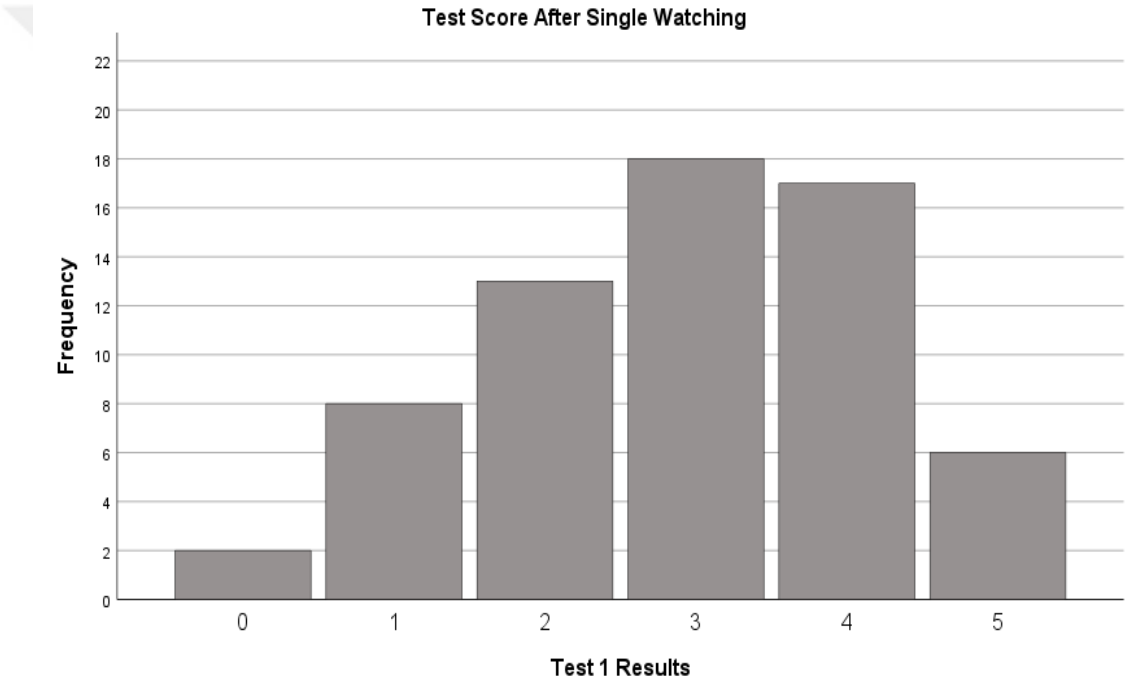

Figure 1. Frequency distribution of Test 1 results

Figure 1 shows frequency distribution of test 1 results.

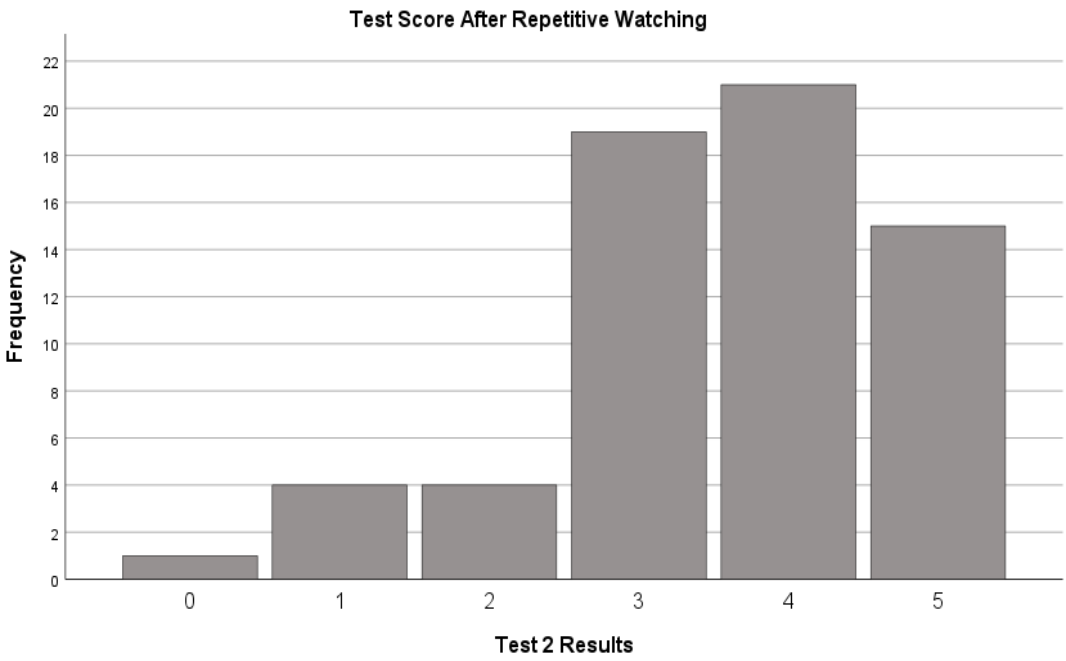

Figure 2. Frequency distribution of Test 2 results

Figure 2 shows frequency distribution of test 2 results. When Figure 1 and 2 are compared, it can be seen that the distribution of scores in the Test 2 were more left skewed showing that on average test scores were higher in Test 2.

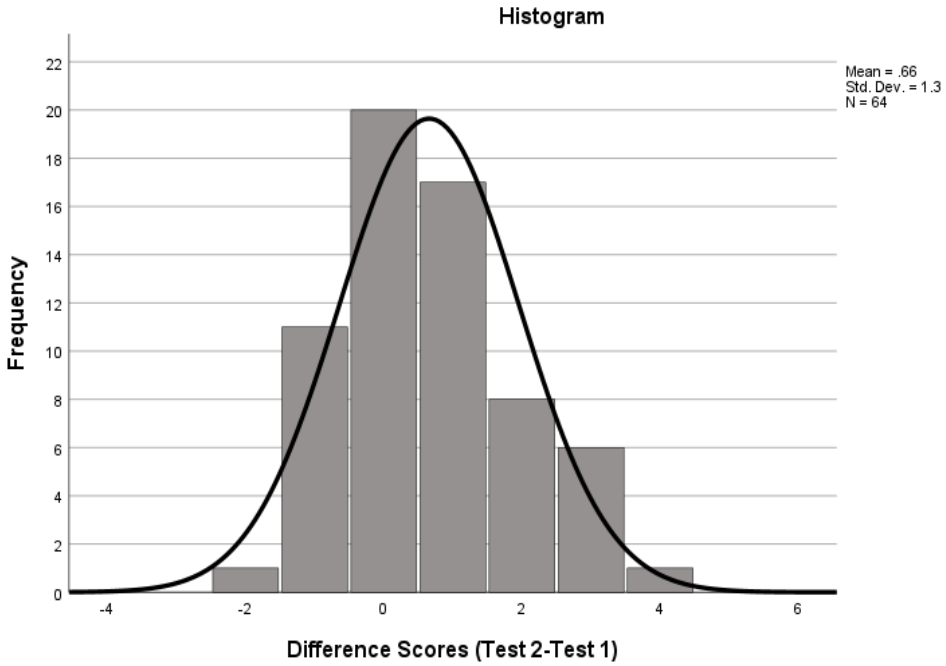

Figure 3. Histogram of difference scores

Figure 3 shows that different scores were distributed approximately normal.

Preliminary Analyses

Video 1 and Video 2 were compared in terms of perceived interest, perceived benefit, English for Video, English for Questions and Perceived prior knowledge of students; and such were similar.Paired Sample T-Test

Assumptions Checking

Outliers

Five outliers were detected that were more than 1.5 box-lengths from the edge of the box in a boxplot. Inspection of their values did not reveal them to be extreme and they were kept in the analysis (Laerd Statistics, 2015)

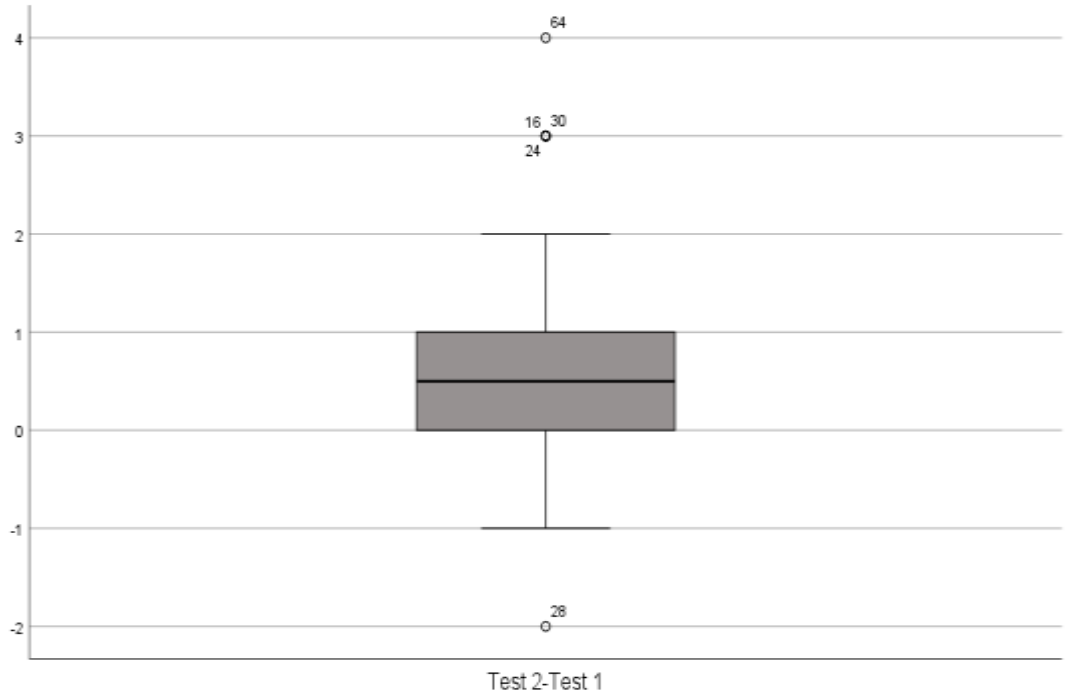

Figure 4. Boxplot

Normal Distribution of Difference Scores

The differences between the test score obtained upon single watching and repetitive watching condition were normally distributed, as assessed by visual inspection of a Normal Q-Q Plot (Laerd Statistics, 2015)

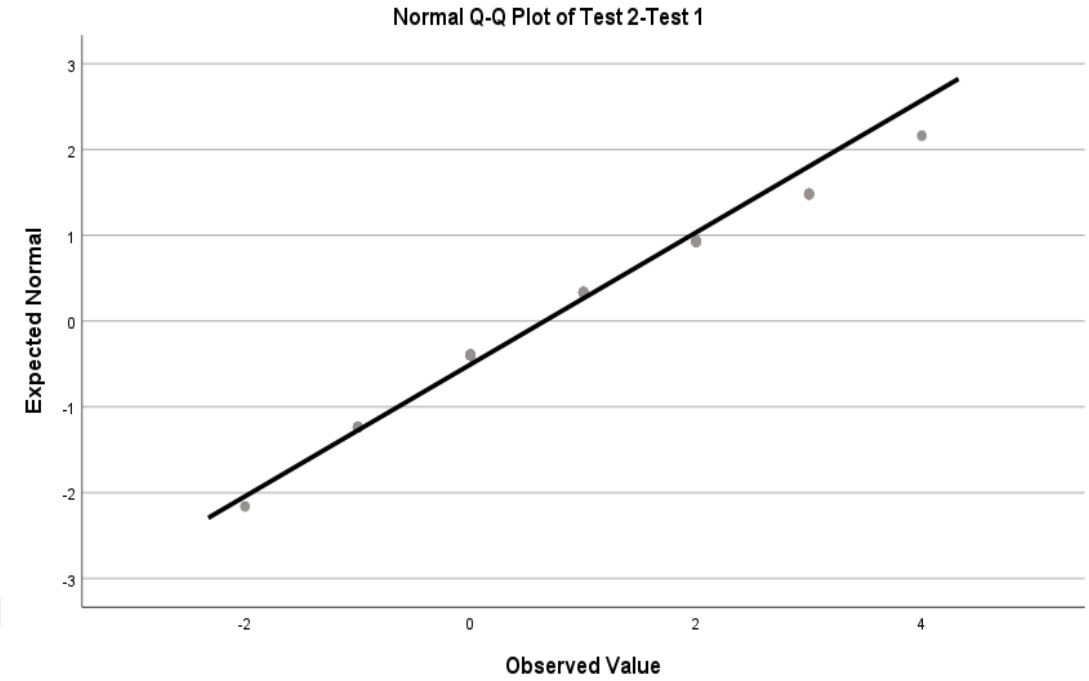

Figure 5. Normal Q-Q Plot of difference scores

Hypothesis Testing

Repetitive watching elicited a statistically significant increase in test score compared to single watching, M = 0.66 (SE = .16), t(63) = 4.04, p < .001 (one-tailed), *d*=0.51.

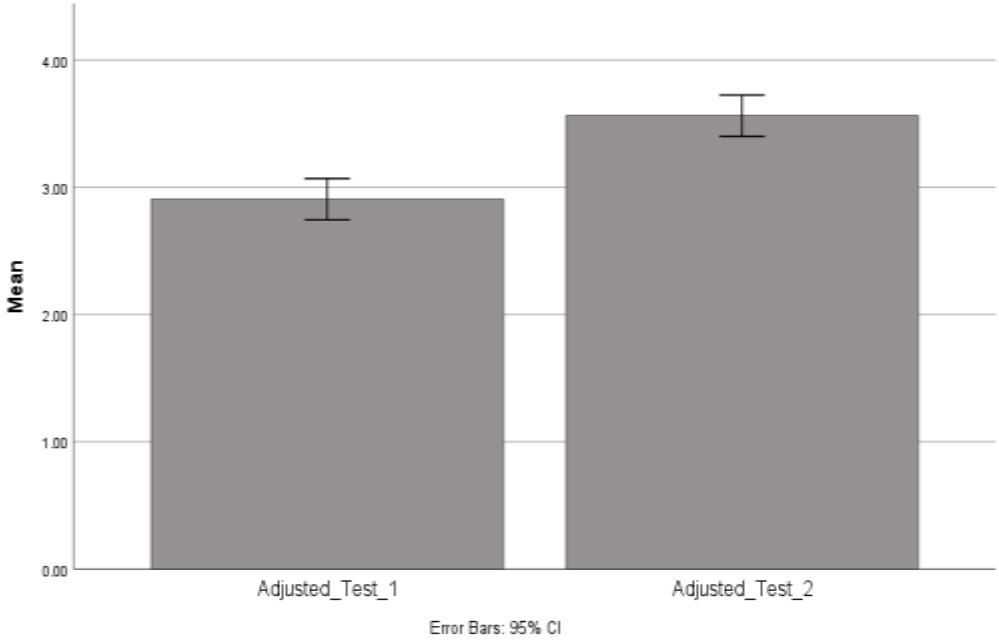

Figure 6. Error bars on adjusted test scores of paired sample t-test

Additionally, a Spearman correlation was conducted on an exploratory basis. The correlation of difference scores (Test 2-Test 1) and perceived prior knowledge was not statistically significant (p=.23) showing that the increase in test scores was independent of prior knowledge.

4.3 Summary

A paired-samples t-test was used to determine whether there was a statistically significant mean difference between the test score obtained when participants watched the video twice compared to single watching. Five outliers were detected that were more than 1.5 box-lengths from the edge of the box in a boxplot. Inspection of their values did not reveal them to be extreme and they were kept in the analysis. The assumption of normality was not violated, as assessed by visual inspection of a Normal Q-Q Plot. Participants test scores were higher after repetitive watching (M=3.56, SD=1.19) as opposed to single watching (M=2.91, SD=1.28), a statistically significant mean increase of 0.66, 95% CI [0.33, 0.98], $t(63) = 4.04$, $p < .001$, d=0.51.

CHAPTER 5

DISCUSSION AND FUTURE DIRECTIONS

5.1 Discussion

Repetitive watching elicited a mean increase of 0.66 points in the achievement test compared to single watching and the effect size was moderate (Cohen, 1988). Effect size seeks to quantify the practical significance of a finding (Laerd Statistics, 2015). In this context, it means that the difference between single and repetitive watching conditions is not just statistically but also practically significant. This supports the alternative hypothesis which stated that participants' test scores will be higher after the repetitive watching condition as opposed to the single watching condition and provide strong evidence that repetition had a significant and meaningful impact on the retention.

In general, it can be said that these results are in line with the following studies: Kiewra et al., 1991 (experiment 1); Kiewra et al., 1996 (analysis 3); Rawson & Kintsch, 2005 (experiment 1_analysis 1); Rawson & Kintsch, 2005 (experiment 1_analysis 2); Rawson & Kintsch, 2005 (experiment 2_analysis 1); Rawson & Kintsch, 2005 (experiment 2_analysis 2); Rawson, 2012 (experiment 1_analysis 1); Karpicke & Blunt, 2011 (analysis 1); Karpicke & Blunt, 2011 (analysis 2); Callender & McDaniel, 2009 (experiment 2_text 2 _analysis 1); Callender & McDaniel, 2009 (experiment 3_text 2_analysis 3); Agarwal et al., 2007 (experiment 2); Rawson et al., 2000 (experiment 2); Millis et al., 2000; Millis & King, 2001 (experiment 1); Millis & King, 2001 (experiment 2); Barnett and Seefeldt, 1989 (analysis 1); Barnett and Seefeldt, 1989 (analysis 2); Amlund et al., 1986 (analysis 1); Amlund et al., 1986 (analysis 2); and Dyer et al., 1979.

From another perspective, it can be also said that these results are in line with previous studies which have used cued recall as the test/cognitive demand of the task. As previously mentioned, 9 out 11 studies which were reviewed for the purpose of literature review of this thesis and which used cued recall, had results in favor of repetition effect.

These results are also in line with theoretical frameworks which state that repetition increase learning and retention through several mechanisms. For instance, to recap major points of Atkinson & Shiffrin's Multi-Store Memory Model (Atkinson & Shiffrin, 1968), which are most relevant to this study, the first one is that many information which enters the sensory register get lost before finding its way to the short-term store (Atkinson & Shiffrin, 1968, p.90, p.95). Put differently, the sensory register can hold a significant amount of information, but only a small fraction of it can transition into short-term memory. Therefore, this study posited that could allow more information to move into short-term memory. This is because learners might focus on various aspects of the stimuli each time, or they might get an opportunity to process previously unnoticed information for many reasons.

The model by Atkinson & Shiffrin (1968) suggests that information remains in short-term memory before transferring to long-term memory, a process influenced by learner-controlled processes but fundamentally automatic. This implies that longer retention in short-term memory—achieved through repetition—strengthens long-term memory traces, essentially enhancing learning and memory consolidation.

In summary, the framework by Atkinson & Shiffrin (1968) highlights a specific mechanism where rehearsal not only temporarily stores information but can also lead to its storage in long-term memory, termed incidental learning. This can occur through two main mechanisms: extending the duration information stays in

short-term memory and allowing control processes more time for the information's transfer to long-term memory. Although this concept is primarily linked to rehearsal within the framework, the study suggests that re-exposure to learning materials (such as re-reading or re-watching) operates on a similar principle of repetition. For example, elaboration, a cognitive strategy for learning, involves linking new information in short-term memory with existing knowledge in long-term memory, which, despite being quick, requires time and may prevent attention to new incoming information. This trade-off highlights the capacity limits of short-term memory and its role in forming connections with long-term memory.

As such, another line of thought which underlined this study is that re-exposure to the learning material may qualify transfer to the long-term store, by way of allowing time for control processes aimed at long-term-storage to take place.

5.2. Limitations

Major limitations of this study are listed below.

i. This study is interested and bounded with a specific type of learning pertinent in certain conditions, i.e. reception meaningful learning as described by Ausubell, 2000 (Please see Theoretical Framework Section-Assimilation Theory of Meaningful Learning and Retention subheading). As such, the results cannot be generalized to other types/activities of learning (e.g. inquiry learning), or other types of knowledge (e.g. metacognitive knowledge) or other materials (e.g. narratives) (Please refer to Assimilation Theory of Meaningful Learning and Retention subheading for more information).

ii. The material (video lecture) which is chosen as the learning material (Please see Method section-Learning Material subheading for more information) is a

relatively short one (app. 3 minutes). Since duration of the material is an important factor of learning through various mechanisms including motivation and attention (Farley et al., 2013), the results can only be generalized to videos of similar length.

iii. The study employed immediate test. In other words, the assessment took place immediately after watching of the lecture. Since the time of testing has the potential to interact with presentation (repetition) condition (Rawson and Kintsch, 2005), the results may not be generalized to the cases where learners take the assessments after longer period time (delayed tests).

iv. Sample of the study consist of students with certain characteristics (Please see Method Section for detailed information) which may not be shared by the larger population -such as age, background knowledge, reading ability, verbal skills, executive functions etc. Since those variables are important determinants of learning and retention (e.g. Dunlosky et al., 2013; Millis and King, 2001; Stine-Morrow et al., 2004), the results can only be generalized to populations with similar characteristics.

v. An important limitation of the study is that participants did not watch the video and took the assessments as a course requirement. As such, their full participations, in terms of the attention and effort they will put into tasks, have completely depended on their intrinsic motivations. As such, although the learning material is chosen from an actual course content to improve the ecological validity of the study, the study, by the very nature of the experimental design, does not mimic the real conditions of an authentic educational context completely.

vi. Although there is only one study which investigated the whether and how prior knowledge moderate rereading effect (Arnold, 1942 as cited by Dunlosky et al. 2013), it is known in general that background knowledge is one of the most important factors in learning and retention (Bransford et al., 2000). In other words, it

is known that pre-existing knowledge might facilitate learning in several ways. As such, prior knowledge might interact with watching condition. participants will also answer a question about how familiar the subjects introduced in the video were familiar to them before watching the video (Please see Method section for more detail). Having said that, this will be self-reported. In other words, there will not be any formal prior knowledge assessment (mostly to isolate the repetition effect from testing effect) which, on the other hand, can also be considered as a limitation of the proposed study.

5.3 Future Directions

This study employed a within-subject design, measured cued recall as the learning outcome, and used relatively short videos as the learning material. These choices were primarily influenced by practical limitations such as time, budget constraints, and the level of experience of the researcher.

One of the first directions for future research would be to investigate the effect of repetition on learning and retention by transitioning to a between-subject design, thereby eliminating the interference of the testing effect. Second direction might be to measure comprehension as the learning outcome, given its greater significance in an educational context. Another direction might be to use longer, and more diverse video lectures can be used to explore the generalizability of the repetition effect.

Additionally, sample of the study consist of students with certain characteristics which may not be shared by the larger population -such as age, background knowledge, reading ability, verbal skills, executive functions etc. Since those variables are important determinants of learning and retention (e.g. Dunlosky et

al., 2013; Millis and King, 2001; Stine-Morrow et al., 2004), future studies might work with different samples to explore the generalizability of the repetition effect.

Another limitation of the study was that it employed immediate test. In other words, the assessment took place immediately after watching of the video. Since the time of testing has the potential to interact with presentation (repetition) condition (Rawson and Kintsch, 2005), future studies might also employ delayed tests to test the durability of the benefit of repetition.

Other directions might be to explore whether executive functions moderate the effect of repetition on learning and retention.

APPENDIX A

CLASSIFICATION OF FINDINGS

Repetition/Re-Exposure Effect	
Support	No Support
1. Kiewra et al., 1991 (experiment 1)	1. Martin et al., 2018
2. Kiewra et al., 1996 (analysis 3)	2. Kiewra et al., 1991 (experiment 2)
3. Rawson & Kintsch, 2005 (experiment 1_analysis 1)	3. Kiewra et al., 1996 (analysis 1)
4. Rawson & Kintsch, 2005 (experiment 1_analysis 2)	4. Kiewra et al., 1996 (analysis 2)
5. Rawson & Kintsch, 2005 (experiment 2_analysis 1)	5. Philips et al., 2016
6. Rawson & Kintsch, 2005 (experiment 2_analysis 2)	6. Rawson, 2012 (experiment 1_analysis 2)
7. Rawson, 2012 (experiment 1_analysis 1)	7. Rawson, 2012 (experiment 1_analysis 3)
8. Karpicke & Blunt, 2011 (analysis 1)	8. Callender & McDaniel, 2009 (experiment 1_analysis 1)
9. Karpicke & Blunt, 2011 (analysis 2)	9. Callender & McDaniel, 2009 (experiment 1_analysis 2)
10. Callender & McDaniel, 2009 (experiment 2_text 2 _analysis 1)	10. Callender & McDaniel, 2009 (experiment 2_text 1 _analysis 1)
11. Callender & McDaniel, 2009 (experiment 3_text 2_analysis 3)	11. Callender & McDaniel, 2009 (experiment 2_text 1 _analysis 2)
12. Agarwal et al., 2007 (experiment 2)	12. Callender & McDaniel, 2009 (experiment 2_text 2 _analysis 2)
13. Rawson et al., 2000 (experiment 2)	13. Callender & McDaniel, 2009 (experiment 3_text 1_analysis 1)
14. Millis et al., 2000	14. Callender & McDaniel, 2009 (experiment 3_text 1_analysis 2)

15. Millis & King, 2001 (experiment 1)
16. Millis & King, 2001 (experiment 2)
17. Barnett and Seefeldt, 1989 (analysis 1)
18. Barnett and Seefeldt, 1989 (analysis 2)
19. Amlund et al., 1986 (analysis 1)
20. Amlund et al., 1986 (analysis 2)
21. Dyer et al., 1979
22. Rothkopf, 1968
23. Mayer, 1983 (experiment 1_analysis 1)
24. Mayer, 1983 (experiment 1_analysis 2)
25. Mayer, 1983 (experiment 1_analysis 3)
26. Mayer, 1983 (experiment 2)
27. Bromage & Mayer, 1986 (experiment 1)
28. Bromage & Mayer, 1986 (experiment 2)

15. Callender & McDaniel, 2009 (experiment 3_text 1_analysis 3)
16. Callender & McDaniel, 2009 (experiment 3_text 2_analysis 1)
17. Callender & McDaniel, 2009 (experiment 3_text 2_analysis 2)
18. Callender & McDaniel, 2009 (experiment 3_text 3_analysis 1)
19. Callender & McDaniel, 2009 (experiment 3_text 3_analysis 2)
20. Callender & McDaniel, 2009 (experiment 3_text 3_analysis 3)
21. Callender & McDaniel, 2009 (experiment 4_text 1_analysis 1)
22. Callender & McDaniel, 2009 (experiment 4_text 1_analysis 2)
23. Callender & McDaniel, 2009 (experiment 4_text 2_analysis 1)
24. Callender & McDaniel, 2009 (experiment 4_text 2_analysis 2)
25. Griffin et al., 2008 (experiment 1)
26. Griffin et al., 2008 (experiment 2)
27. Rawson et al., 2000 (experiment 1)
28. Dunlosky & Rawson, 2005 (analysis 1)
29. Dunlosky & Rawson, 2005 (analysis 2)
30. Bromage & Mayer, 1986 (experiment 3)

APPENDIX B

VIDEOS

Video 1 (Epistemology)

Link: https://www.coursera.org/learn/quantitative-methods/lecture/B7gDd/1-07-epistemology

Video 2 (Ontology)

Link: https://www.coursera.org/learn/quantitative-methods/lecture/HGPKl/1-08-ontology

APPENDIX C

TEST QUESTIONS

Pair of Questions for Video 1 (Epistemology)

- Epistemology is the field of philosophy concerned with the study of _____. (knowledge)
- Ontology is the field of philosophy concerned with the study of _____. (existence)
- According to rationalists, we can deduce truths about the world using our mind's capability for logical, rational thought, without having to rely on _____. (experiences)
- Rationalists hold that knowledge is gained through _____. (reason)
- According to rationalists like Plato and _____, some abstract concepts about the structure of nature are innate. (Descartes)
- _____ famously said, "The book of nature is written in the language of mathematics." (Galileo)
- Empiricism and rationalism represent two different _____ perspectives in philosophy. (epistemological)
- Empiricists think that individuals are born with a _____. (blank slate)
- In constructive empiricism, the aim is to come up with empirically adequate explanations that match _____. (observations)
- Constructive empiricists believe that the truth or falsity of _____cannot be determined. (unobservables)

Pair of Questions for Video 2 (Ontology)

- Ontology, also known as the study of _____, delves into questions about the nature of existence. (being)
- Ontology is the philosophical discipline that seeks to answer the fundamental question, "What is the nature of _____? (reality)
- Materialism asserts that everything in the independent physical reality consists entirely of _____. (matter)
- Materialism is a position that accepts an external world _____ of our mind. (independent)
- _____ are specific instances or occurrences in which a property can be observed. (particulars)
- _____ are general properties that cannot be observed directly. (universals)
- _____ realism states that it's possible to make consistently supported claims using universals in statements about observable phenomena. (scientific)
- _____ realism suggests that universals exist on a separate abstract plane. (platonic)
- _____ is a philosophical view that asserts that reality as we perceive it exists entirely within our mind. (idealism)
- In _____ there is no such thing as gravity or love and we just use these terms because they help us make sense of the world. (nominalism)

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