Loading… Loading… The Influence of Download Time on Information Search

by

Alyssa Catherine Smith

A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Arts

in

Psychology

Waterloo, Ontario, Canada, 2019

Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Alyssa Smith was the primary author of the manuscript, conceived the experimental design, and analyzed the data.

Brandon Ralph assisted with the experimental design and writing the manuscript.

Jeremy Marty-Dugas assisted with the experimental design, editing the manuscript, and data analysis.

Daniel Smilek guided the research process, including the experimental design, data analysis, and the writing of the manuscript.

Abstract

When browsing online, there is considerable variation in the amount of time that one has to wait for content to appear once the link to that content has been activated (i.e., clicked). In two experiments we examined how 'download time' – a barrier to information accessibility – influences search behaviour, and the role that individual differences play in the foregoing relation. In both experiments, participants completed a video-watching task in which they were presented with a screen containing six clickable icons, each of which represented a unique video. When participants clicked an icon, a video would begin to load and then play. Their task was to gain as much information from the videos as possible for a later memory test. Critically, however, the 'download time' of the available videos (i.e., the time between the click on the icon and the video beginning to play) varied. In Experiment 1, these load times were 0 (instant), 2, or 30 seconds, and in Experiment 2, they were 5, 15, and 30 seconds. In general, we found that participants terminated and avoided videos with longer download times than videos with shorter download times. Interestingly, this effect was attenuated when the experienced download times were more similar to each other (Experiment 2) than when they were more different from each other (Experiment 1).

Acknowledgements

I would like to thank my supervisor, Dan Smilek for his guidance and enthusiasm during my training. Your encouragement has helped me to accomplish more than I thought during my masters. I am so grateful for the opportunity to continue working with you. I would also like to thank Brandon Ralph for his encouragement, insight, and patience with my (many) questions, and thank you to Jeremy Marty-Dugas for his support and assistance with data analysis (especially his patience as I learned to use R). Thank you to my labmates, Emilie, Lydia, Bruno, Allison, and Tyler, for such a supportive lab environment. Finally, thank you to the National Science and Engineering Research Council of Canada (NSERC) who supports our lab through a discovery grant to Daniel Smilek. This work is currently under review at *PloS one*.

Dedication

To my loved ones, my parents, Allan and Janet, my sister Caitlin, and Jeremy – thank you for your support, and your unwavering belief in me and what I'm capable of. I couldn't do this without you.

Table of Contents

List of Figures

List of Tables

Introduction

The practice of controlling the flow of, and access to, information in the public sphere has a long history in modern societies, not only in those typically labeled as being repressive and authoritarian, but also in those that are typically thought of as "free" democracies (see Bernays, 1928/2005; Lippmann, 1922; 1925; see Chomsky, 2002 for a review). After propaganda was successfully used during the First World War by the British and American governments to goad their own populations into the war, influencers such as Edward Bernays (now often thought of as the father of public relations) and the Pulitzer Prise winning journalist Walter Lippmann, promoted the use of information control to manage public opinion (Bernays, 1938; Lippmann, 1922; 1925; see Chomsky, 2002 for a review). They saw such control as necessary for democracies to function smoothly, since the control of information by the 'most capable' few in society could keep the less capable masses on the 'right track' (Lippmann 1922). Along these lines, in his now classic work titled "Propaganda"(1928/2005, p. 37-38), Edward Bernays wrote the following:

> "The conscious and intelligent manipulation of the organized habits and opinions of the masses is an important element in democratic society. Those who manipulate this unseen mechanism of society constitute an invisible government which is the true ruling power of our country."
>
> ". . . it remains a fact that in almost every act of our daily lives, whether in the sphere of politics or business, in our social conduct or our ethical thinking, we are dominated by [a] relatively small number of persons . . . who understand the mental processes and social patterns of the masses. It is they who pull the wires which control the public mind, who harness old social forces and contrive new ways to bind and guide the world."

Control over information can be achieved in many ways, though two common tactics include the promotion of information deemed to be desirable and the suppression of information deemed to be undesirable. As internet platforms quickly become the new 'public square', the use of these information control tactics is already evident by major social media platforms. There are cases of complete 'de-platforming' (erasing people from a given platform; Schwartz, 2019), however, such actions are often viewed as being too heavy handed, as they evoke generally distasteful thoughts of censorship. In addition, the growing number of internet platforms, and innovations like block-chain technology, make it increasingly difficult to completely remove content from the internet (see Rogan, 2019). For these reasons, technology companies and other influencers are turning to more subtle means of controlling what information enters the public consciousness.

In a recent interview, Twitter co-founder Jack Dorsey commented on how information can be more subtly controlled in an age when it is becoming difficult to completely remove 'unwanted' voices from internet platforms like Twitter (Rogan, 2019). Dorsey describes how Twitter is using 'verified badges' to identify "that an account of public interest is authentic" (https://help.twitter.com/en/managing-your-account/about-twitter-verified-accounts) and how they plan to develop new ways to identify an 'expert' so that they can be labeled as such on the platform. Using such tools, they hope to 'amplify' the 'healthy' voices on the platform. In addition, one of Dorsey's 'bunch of tools' for controlling information flow is to 'downrank' certain tweets in the feed (i.e., placing them lower on the list), so that they are less likely to be noticed (these are claimed to be those that are flagged by an algorithm as reflecting aggressive behavior).

The effectiveness of down-ranking information as a tool for discouraging information access can be understood from extant models of information foraging (Fu & Pirolli, 2007; Pirolli, 2005; Pirolli & Card, 1999; Pirolli & Fu, 2003). 'Diet models' of information foraging seek to explain search behaviour through the lens of profitability – that is, information gained per unit of time/energy cost. The assumption is that people seek to maximize their gains over costs. From this perspective, down-ranking decreases the profitability of select informational sources by increasing the amount of time and energy required to locate the down-ranked source. With many other potential information sources available, people ought to be more likely to ignore down-ranked information in favour of more readily available alternatives. In addition to modifying the 'informational diet', down-ranking might also impact 'informational scent'. Information scent models describe search behaviour according to cues that might suggest higher and lower yield sources of information. Like informational diet models, informational scent models stipulate that people will follow cues with the greatest promise of return for their investment. Based on implicit assumptions and explicit statements about technologic search algorithms, down-ranked sources might be perceived as lower in informational quality and/or yield, and should therefore be less sought after. Taken together, down-ranking is an effective tool for discouraging access both because it (a) decreases profitability by increasing time-costs and (b) provides cues that typically signal poor information quality/yield.

Intuitively, and based on information foraging theory, another way to discourage access to information may involve simply increasing the time required to access information (without down-ranking). In the realm of online human-computer interactions, for instance, longer delays to accessing online content has been associated with reduced user satisfaction (Hoxmeier & DiCesare, 2002; Ramsay, Barbesi, & Preece, 1998), unfavourable attitudes towards future use or revisiting of such content (Galletta, Henry, McCoy, & Polak, 2004), and reduced commerce (Diclemente & Huntula, 2003; Rajala & Hantula, 2000). Importantly, increased delays to access information have been associated with increased self-reported intentions to abort access altogether (Rose, Lees, & Meuter, 2001). Thus, it makes sense that many developers and distributers seek to minimize access delays to promote access to their information or product. However, the foregoing findings also suggest that delays could be used to discourage access to undesirable information.

Access delays have already been implemented in at least one smartphone application designed to discourage habitual media use. In a *60-mintues* interview, Ramsey Brown, the founder of Dopamine Labs, described an application his team developed (named *Space*), which, at the time of the interview, could be configured to create a short delay when a user tries to access various applications on his or her smartphone (Bast and Campanile, 2017). The application was based on the notion that delaying access will increase the tendency of access abandonment, with the altruistic goal of breaking or preventing addictive smartphone/media use.

The Present Studies

Against this backdrop, in the present paper we sought to further explore how varying the time it takes to access or 'download' information on the internet can serve as a barrier that influences people's tendency to access target information, even though the information is accessible. We were interested in exploring this issue because it may play an important role in ongoing debates about information control on the internet. For instance, understanding how varying download time influences information acquisition will be important for informing ongoing discussions about net neutrality and throttling of internet and network speeds (Collins, 2018; Kharif, 2018; Nowak, 2008).

Here we present two experiments that build upon prior work linking download times with self-reported intentions to abort information access (Rose et al., 2001). Rather than focusing on self-reports, however, we examined actual search behaviour as participants encountered content with variable (rather than homogenous; as per Dennis and Taylor, 2006; Liu et al., 2016) access delays in a given search session. In the present studies we had participants complete a video viewing task. On each trial, participants were presented with a screen containing six clickable icons, with each icon representing a video. Participants were asked to view as many of the videos as possible within a five-minute time limit. The videos could not be viewed in their entirety within the time limit. When an icon was clicked, the corresponding video would be queued to play. The key feature of this paradigm was that we systematically manipulated the 'download time' of the videos (e.g., for 0, 2 or 30 seconds). We defined 'download time' as the time elapsed between a click on the icon and the time the video started to play. During the session, participants had complete control over which video they viewed, such that participants could start and switch between videos (by clicking another icon) at any time, with the only limitations being that just one video could play or be downloading at a time, and progress through a video would reset upon switching. Participants were informed that they would be tested on the contents of all of the videos after the video viewing time was completed.

This paradigm allowed us to examine the relation between download time and information access under conditions in which participants are given the opportunity to switch between information sources during a download. With regard to participant search behaviour, we focused on how varying information download time would influence (a) the proportion of times a download was terminated/aborted after a download has been initiated, (b) the tendency to waiting through a download and actually start viewing the target content, and (c) the tendency to finish consuming information content after viewing of the content has begun. Of course, these behaviors may be correlated with each other, but we included each of these as related measures of information consumption that might be influenced by download time. We hypothesized there would be a relation between download time and download terminations, such that during longer download times individuals would abandon the download in favor of accessing another video. Relatedly we also expected to find a bias whereby participants access (i.e., begin to view) information from more sources with shorter download times than those sources with longer download times. Finally, based on prior work (Dennis and Taylor, 2006) we expected that increasing download time may increase the number (and rate) of videos viewed to completion.

Experiment One

In Experiment 1, we examined how relative differences in download times influenced which information people accessed. For our initial investigation we chose download times with a large contrast – 0s, 2s, or 30s—to establish whether the relative differences in the download times would have any impact on the participants' video viewing behaviour. If an effect was to be found, it would be largest (and easiest to observe) with download times with marked differences. We included a 0-second download condition to have a condition that might strongly contrast with the slower download times (even though a termination is virtually impossible during a 0-second download). We also had participants complete an end-of session strategy sheet to evaluate their awareness of the download time manipulation.

Method

Following the recommendations of Simmons, Nelson, and Simonsohn (2012), we report on how we determined our sample size, all manipulations, all measures, and all data exclusions in this study.

Participants. It was determined, a priori, that we would aim to collect data from 100 participants, as this is a reasonably large sample for within-subject comparisons with a reasonable time-cost of data collection. In total, 102 undergraduate students from the University of Waterloo participated in exchange for partial course-credit. Slight overshooting of our approximated sample size was due to participants being run in groups and the anticipated occurrence of 'no shows'.

Materials.

Videos. Videos presented during the video viewing task were 50- to 70-second clips from Ted Talks on a wide range of topics (Geography, Physics, Psychology etc.). A full list of videos can be found in the Supplementary Materials (Appendix A).

Videos were represented as clickable icons, and each trial contained six videos. Two videos had a 0-second download time, two videos had a 2-second download time, and two videos had a 30-second download time. Participants had 5 minutes to view the videos within each trial, and there was a timer counting down from 5 minutes in the upper left corner of the screen (Figure 1).

Self-reported motivation. For exploratory purposes, following the 5 trials of the video viewing task, participants were asked to rate how motivated they were to watch as many videos as possible. This was done using a scale ranging from 1 to 7 (1 = not motivated at all, 7 = extremely motivated). A copy of the motivation question can be found in Supplementary Materials (Appendix B). The motivation question was included only for exploratory purposes.

End of session quiz. After responding to the motivation question, participants completed a true/false quiz on the video content. The quiz consisted of one question derived from the content of each video (30 questions total). The purpose of the quiz was 1) to prevent suspicion about the download time manipulation, and 2) to motivate participants to move through as many videos as possible during each trial. A copy of the quiz can be found in Supplementary Materials (Appendix C).

End of session strategy sheets. To measure whether participants were cognizant of our manipulation of the download time prior to viewing the videos, we asked participants (at the end of the experiment; after the quiz) to describe any strategies they used while viewing the videos. A session strategy response sheet was placed face-down beside the computer prior to the beginning of the experiment (see Supplementary Materials, Appendix B). At the end of the experiment, participants turned over the sheet and wrote their responses by hand.

Procedure.

Video Viewing Task. Participants were tested in groups of one to five, depending on volunteer enrollment for a given session. Participants were each seated at a computer with dividers between them so they could not observe other participants' behaviour during the experiment. Participants were given verbal instructions for the video viewing task and then completed a 1-minute demonstration of the video viewing task with the research assistant. The instructions given for the task are provided in the Supplementary Materials (Appendix B).

Participants completed five trials of the task. On each trial, participants were presented with six black clickable icons on the screen (Figure 1A). Each icon represented a video, and clicking an icon queued that video to play. Prior to a video starting participants could not preview the video content (unless they had already viewed a portion of that video earlier during that trial).

Critically, we systematically manipulated the video download time, which we define as the time that elapsed between the video placeholder being clicked and the moment the video began to play; the download times were 0-, 2-, or 30-seconds. During the download time, participants were shown a "loading…" message to indicate the computer was processing their request (Figure 1B). No other information was provided on the length of the download time. Following the allotted download time, the video began to play (Figure 1C). To motivate participants to be strategic with regard to their video viewing choices, they were not given enough time to fully watch all six of the videos (even though they were told they would be tested on the content from all of the videos). Specifically, while participants were only given 5 minutes to watch the videos on a given trial, it would take a total of approximately 6 minutes for the videos to play sequentially. Participants could start and switch between videos at any time (even during the download) by clicking another video.

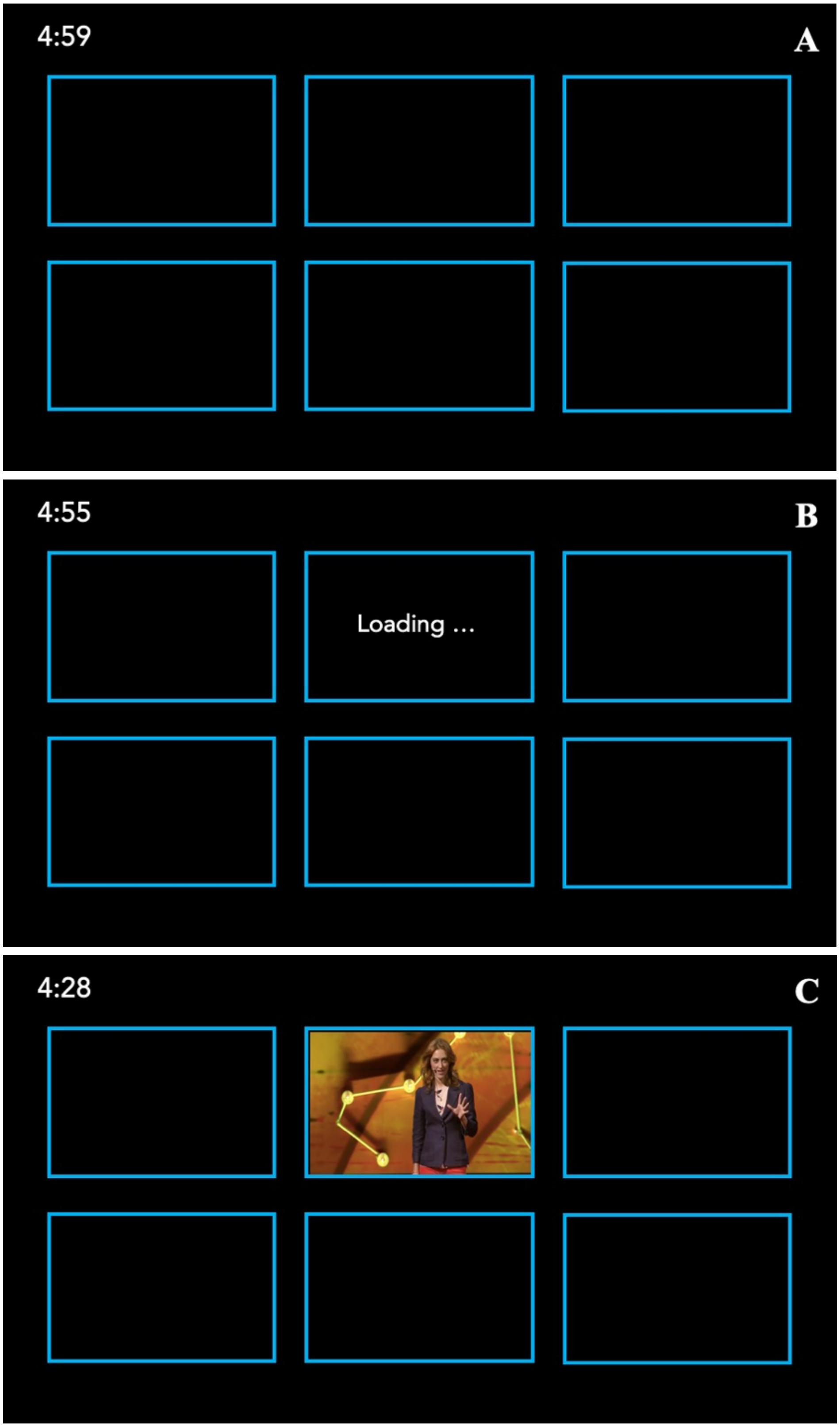

Figure 1. A schematic depiction of the displays that participants viewed on each trial. Included are depictions of what participants saw at the beginning of the trial (Panel A), when they clicked one of the video placeholders and the video began to load (Panel B), and when the video was playing (Panel C).

Following completion of the video viewing trials, participants were presented with the motivation question. Participants then completed a comprehension quiz on the video content.

Results

Prior to analysis, one participant was excluded because they were given the wrong instructions, and two participants were excluded due to technical difficulties during the experiment.

Descriptive Statistics. Our three primary objectives were assessed via four key dependent variables. First, the tendency to (A) terminate/abort access during a download was measured via the *proportion of terminated downloads*, which was calculated as the number of videos that were terminated during the download time divided by the total number of videos that were queued to load (i.e., clicked). Second, the tendency to (B) wait through a download was measured via the *number of videos started*, which was calculated as the number of videos that began to play after participants had waited through the download time. Lastly, the tendency to (C) finish information content after waiting through a download was tracked via both the *number of videos finished* and the *proportion of videos finished*, which was calculated as the number of videos that were watched to the end divided by the total number of videos that started to play on a given trial. When making the proportion of videos finished calculation, we excluded videos that started as the last event in a trial (as videos started as the last event in a trial would likely not have enough time left to be finished). Each of these measures was computed for each trial for the separate download time conditions (0, 2 and 30 seconds); the measures for each condition were then averaged across the 5 trials.

As can be seen in Table 1, all measures were normally distributed (skew <3, kurtosis <10; Kline, 1998) except for the proportion of terminated downloads for videos with a 0-second download time and the proportion of terminated downloads for videos with a 2-second delay, which were found to approach a non-normal distribution. Since some key variables of interest were non-normally distributed, and our data involves counts of events, we decided to analyze our key variables using non-parametric analysis techniques (Friedman test and Wilcoxon signed-rank tests). Descriptive statistics of the key variables are provided in Table 1.

Table 1
Descriptive statistics of variables for experiment one (N=99)

Measure	*Mean*	*Median*	*SD*	*Skew*	*Kurtosis*
Proportion of Terminated Downloads					
0 seconds	0.00	0.00	0.00	9.95	99.00
2 seconds	0.07	0.00	0.14	2.45	6.27
30 seconds	0.54	0.67	0.31	-0.7	-0.96
Number of Videos Started					
0 seconds	1.85	2.00	0.38	-2.52	5.81
2 seconds	1.82	2.00	0.43	-2.43	5.41
30 seconds	0.56	0.20	0.75	0.93	-0.63
Number of Videos Finished					
0 seconds	1.39	2.00	0.72	-0.74	-0.74
2 seconds	1.34	2.00	0.77	-0.68	-1.00
30 seconds	0.26	0.00	0.51	1.82	2.48
Proportion of Videos Finished					
0 seconds	0.81	0.90	0.27	-1.56	1.44
2 seconds	0.79	0.90	0.28	-1.51	1.32
30 seconds	0.70	1.00	0.40	-0.93	-0.78

Note: Proportions and numbers of videos averaged across 5 experimental trials
Term. Downloads (proportion) = the proportion of videos terminated during the download time of the total number of videos queued to load (per trial)
Videos Finished = the number of videos finished (watched to the end) (per trial)
Videos Finished (proportion) = the proportion of videos finished (watched to the end) of videos started (per trial)
Videos Started = the number of videos started after the download time

Given that our dependent variables were derived from common viewing attempts, we conducted Spearman rank-order correlations among our dependent variables for the 30-second and 2-second download time (see Table 2). We excluded the 0-second download time from our correlational analysis because terminations were nearly impossible in that condition. As can be seen in the table, the magnitude (absolute value) correlations between measures varied from .01 to .83 and the correlations varied widely between the two download time conditions. Clearly, however, none of the correlations were equal to 1, indicating that no two of our measures were identical.

Table 2

Correlations of dependent variables for experiment one (N=99)

	1	2	3	4
2-second download time				
1. Proportion of terminated downloads		-.14	-.11	-.01
2. Number videos Started			.43*	-.20*
3. Number videos finished				.67**
4. Proportion of videos finished				
30-second download time				
1. Proportion of terminated downloads		-.83**	-.75**	-.11
2. Number videos Started			.76**	-.19
3. Number videos finished				.58**
4. Proportion of videos finished				

** $p < .001$, * $p < .05$

Proportion of Terminated Downloads (Figure 2). When analyzing the proportion of terminated downloads, we did not use an omnibus Friedman test to assess differences across all three download times because the structural constraints of the design meant that there could be no (or almost no) terminations in the 0-second download time condition. Instead we focused on comparing the proportion of terminated downloads across the 2-second and the 30-second conditions. Wilcoxon signed-rank tests indicated that there were significantly more terminations during the download interval for videos with a 30-second download time than videos with a 2-second download time, $p < .001$, $r = -0.55$. For the sake of completeness, we also include the other pairwise comparisons. As might be expected, there were significant differences between videos with 30-second and 0-second download times, p <.001 , r = -0.56, and also between videos with 2-second and a 0-second download times, p <.001, r = -0.34. Of course, these findings are not surprising since videos with a 0-second delay began playing immediately after being queued (i.e., clicked).

As an aside, it is worth noting that the total number of videos queued, which served as the denominator in the calculation of the proportion of terminated downloads measure, differed across download conditions ($x^2(2) = 57.96$, $p < .001$). However, when we look at the number of first clicks on videos (i.e., to measure whether participants are disproportionately initially clicking on videos with a 30-second download time), there was no significant difference between download times ($x^2(2) = 3.01$, $p = .222$). Therefore, the greater number of clicks observed on the 30-second download time videos was due to participants terminating the download, queuing another video, and then returning to the save video with the 30-second download at later time in the trial and queuing that video to load an additional time.

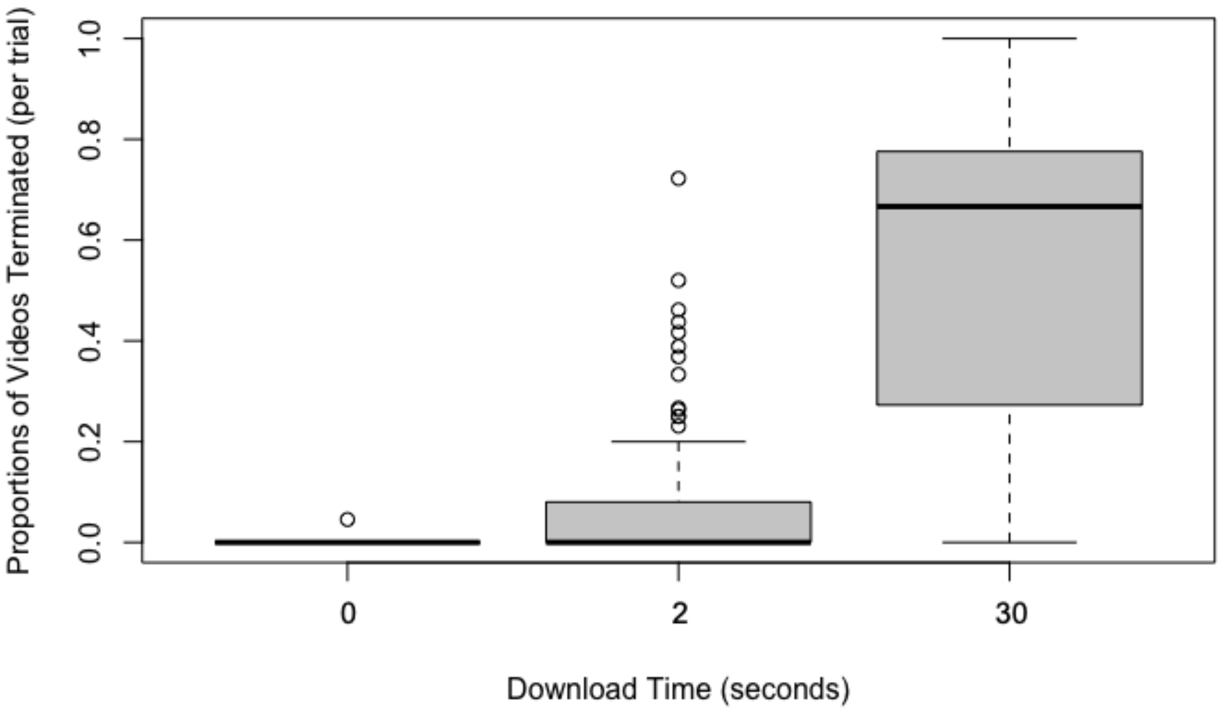

Figure 2. Box and whisker plots (boxplots) of the proportion of videos terminated during the download time as a function of the download time[1].

Number of Videos Started to Play. A Friedman test revealed that there was a statistically significant difference in the number of videos started across the three download time conditions ($x^2(2) = 512.96$, $p < .001$; see Figure 3). Post-hoc Wilcoxon signed-rank tests indicated that there were significantly fewer videos that started to play with a 30-second download time than a 2-second download time, $p <.001$, $r = -1.19$. There were also significantly fewer videos that started to play with a 30-second download time compared to a 0-second download time, $p <.001$, $r = -1.22$. There was no significant difference between videos with a 2-second and a 0-second download time, $p = .200$, $r = -0.09$.

[1] One participant terminated a download of a 0-second download time video. This was due to the participant clicking all the videos in rapid succession.

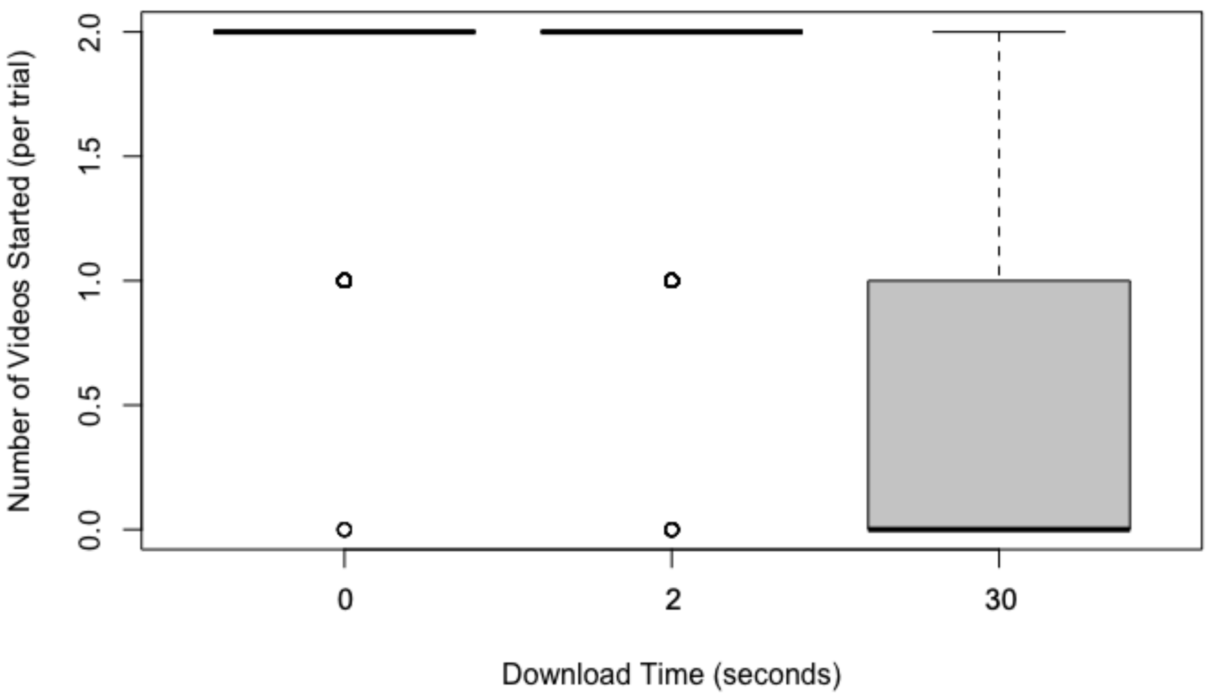

Figure 3. Box and whisker plots (boxplots) of the number of videos started as a function of the download time.

Number of Videos Finished. Applying the Friedman test, we found that the number of videos finished differed across the three download time conditions, ($x^2(2) = 100.37$, $p < .001$; see Figure 4A). Post-hoc Wilcoxon signed-rank tests indicated that there were significantly fewer videos finished with a 30-second download time than a 2-second download time, $p <.001$, $r = -0.56$. There were also significantly fewer videos finished with a 30-second download time than a 0-second download time, $p <.001$, $r = -0.57$. There was no significant difference in the number of videos finished between videos with a 2-second download time and videos with a 0-second download time, $p = .337$, $r = -0.07$.

Proportion of Videos Finished (Figure 4B)[2]. Prior to analyzing the proportions of videos finished (i.e., the number of videos finished as a proportion of the number of videos started), we excluded video starts that were the last event in any given trial. Since participants only had 5 minutes

[2] In this analysis we excluded videos that were started as the last event in any given trial, as there was not enough time for such videos to finish.

to view the 6 videos in each trial, if the video start was the last event, there was not enough time left for the participant to finish that video. This excluded on average one video start per trial for each participant.

Applying the Friedman test, we found that the proportion of videos finished did not differ across the three download time conditions ($x^2(2) = 0.92$, $p = .631$; see Figure 4B).

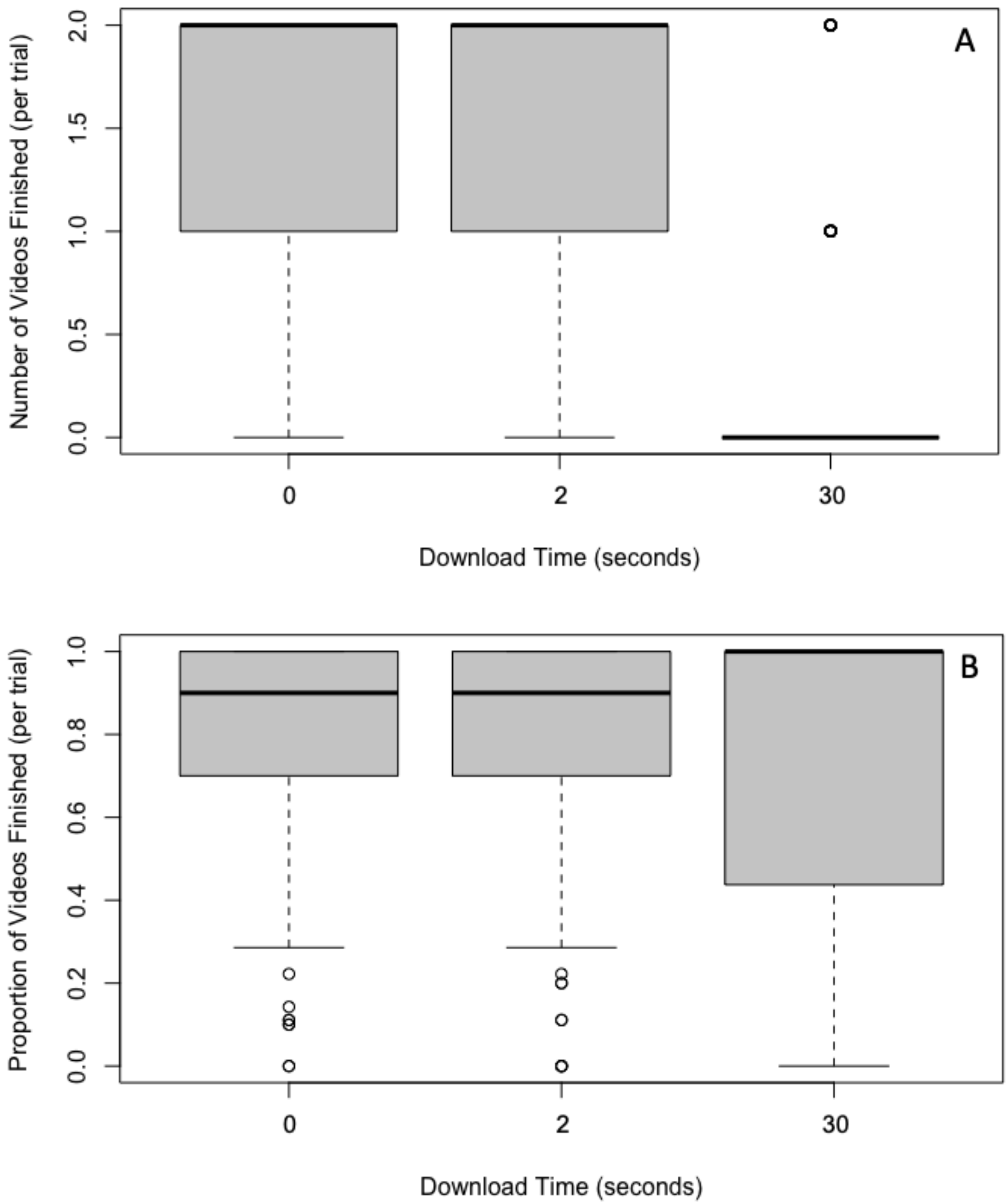

Figure 4. Box and whisker plots (boxplots) of the number of videos finished (A); and as a proportion of videos stared (B) as a function of the download time.

Motivation. We found there were some significant correlations between the video watching measures of interest and self-reported motivation. Since the self-reported motivation measure was an exploratory measure and not a main measure of interest, we included the analyses in the Supplementary Materials (Appendix D).

End of Session Strategy Sheet. Forty participants (40%) noted a difference in download times between videos, and 3 of those 40 participants indicated they suspected that download time was varied intentionally. The remaining participants indicated they moved through the videos either by watching the videos that interested them or by watching a certain time-period of each video, enabling them to watch at least a small portion of each video.

End of Session Quiz. Since participant performance on the quiz was at ceiling, we did not analyze it in relation to our video watching variables of interest. On average participants answered 86% of questions correctly, with scores ranging from 63-97%.

Discussion

The goal of Experiment 1 was to examine how relative differences in download times influenced information access (i.e., viewing of videos) when participants had the freedom to terminate and switch between information sources, even during the download period. Our findings indicate that participants accessed more information with shorter download times than information with longer download times. This effect was consistent across several of the primary measures of interest. First, in terms of the proportion of videos terminated during download, we found participants terminated more downloads that were 30-seconds than those that were 2- or 0-seconds. Second, we examined the number of videos started (i.e. those cases in which participants waited through the download time and let the video begin to play) and found that participants started the fewest videos with a 30-second download time. Lastly, in terms of the number of videos finished, we found that compared to videos with a 2- or 0-second download time, participants also finished fewer videos with a 30-second download time. However, when we computed the number of videos finished in each condition as a function of the number of videos started in each condition, the resulting proportion of videos finished did not differ across download time conditions. This suggested that the differences between conditions in the number of videos that were finished was a direct function of the differences between conditions in the number of videos that were started. Nevertheless, the data clearly show that participants consistently accessed videos with a 30-second download time less frequently than videos with a shorter download time (0-seconds, 2-seconds).

The finding that participants finished an equal proportion of videos started with a 30-second download time as those with the 2-second and 0-second download times, is somewhat surprising as it is inconsistent with prior work conducted by Dennis and Taylor (2006). Dennis and Taylor (2006) had participants complete a web search task in which a given search session included webpages that had a homogenous download times—all either short (0.5 seconds) or long (7 seconds) download times. The goal of their study was to explore how the download time in a given session influenced the length of time participants spent on a webpage following its download. The authors found participants who experienced long (i.e., 7 seconds) download times prior to viewing each webpage spent more time on that webpage than individuals who experienced shorter (i.e., 0.5 seconds) download times. Based on these findings, one might expect that in our study, participants ought to finish more of the videos they started that were associated with the longer download time than the shorter download times. However, this is not what we found.

One possible explanation for this discrepancy revolves around what might be a key methodological difference across studies: Namely, Dennis and Taylor (2006) included the same download time for all webpages in a given session (i.e., a homogenous download time in a session), whereas in our study, each information gathering session (i.e., trial) included videos with a variety of download times (i.e., heterogenous download times in a session; of 0-, 2-, and 30-seconds). It is worthwhile to consider the impact of this design difference from the perspective of information foraging theory. In Dennis and Taylor's study, the homogenous download times in a given search session might have led participants to treat the download time as a fixed component of the *switch cost* in the session; which would mean that longer download times in a session should be associated with fewer switches, and thus longer viewing times of a given webpage, in that session. Because in our study the video download times in each session were heterogenous (i.e., there was no fixed switched cost) such a dynamic might not have emerged. In addition, in our study, participants were told they would be tested on the content of *all* the videos (regardless of download time), thus they may have been more motivated to continue viewing videos once they had begun since participants knew they would be tested on the content.

Experiment Two

In Experiment 2 we sought to evaluate whether the pattern of results found in Experiment 1 would change qualitatively if a different set of download times were used. The download times used in Experiment 1 included very short (0-seconds and 2-seconds) and very long (30-seconds) times, which could be perceived as being very disparate. In addition, one of the download time conditions involved no download time at all, which might have had a large impact on participant behavior. In Experiment 2 we included more similar download times (5-, 15-, and 30-second), with our short download time being non-zero. We expected to find similar patterns of results as those found in Experiment 1. Specifically, we hypothesized there would be a greater proportion of terminated downloads for videos with a 30-second download time than videos with 5-second or 15-second download times. We also hypothesized there would be fewer videos started with a 30-second download time, and fewer videos finished with a 30-second download time.

Method

Participants

It was determined, a priori, that we would aim to collect data from 100 new participants (who did not participate in Experiment 1), to match the sample size in Experiment 1. In total, 94 undergraduate students from the University of Waterloo participated in exchange for partial course-credit. Slight undershooting of our approximated sample size was due to the term ending preventing us from collecting more data. Instead of continuing to data collection into the next term, we decided to analyze the data we had at the end of the term.

Materials.

The materials were identical to those used in Experiment 1.

Procedure.

The procedure was identical to that of Experiment 1 with the exception that the video download times were 5-, 15- and 30-seconds.

Results

Prior to analysis, two participants were excluded due technical issues during the experiment, and one participant was excluded because they fell asleep during the experiment.

Descriptive Statistics. Descriptive statistics for our key measures of interest—proportion of terminated downloads, number of videos started, and number (and proportion) of videos finished—are presented in Table 3 As can be seen in Table 3, the proportion of terminated downloads for videos with a 5s download time was found to approach a non-normal distribution. All other variables were found to have a normal distribution (skew <3.0 and kurtosis <10.0; Kline, 1998). To allow comparison of results across studies, we decided to again analyze our key variables using non-parametric measures (Friedman test and Wilcoxon signed-rank tests).

Table 3

Descriptive statistics of variables for experiment two (N=91)

Measure	*Mean*	*Median*	*SD*	*Skew*	*Kurtosis*
Proportion of Terminated Downloads					
5 seconds	0.03	0.00	0.06	2.66	8.27
15 seconds	0.04	0.00	0.08	2.66	7.83
30 seconds	0.12	0.00	0.21	2.11	3.87
Number of Videos Started					
5 seconds	1.52	2.00	0.59	-0.78	-0.37
15 seconds	1.49	2.00	0.59	-0.70	-0.47
30 seconds	1.42	2.00	0.68	-0.74	-0.59
Number of Videos Finished					
5 seconds	0.69	1.00	0.72	0.52	-0.92
15 seconds	0.71	1.00	0.69	0.45	-0.87
30 seconds	0.67	1.00	0.67	0.49	-0.74
Proportion of Videos Finished					
5 seconds	0.62	0.75	0.38	-0.44	-1.39
15 seconds	0.66	0.80	0.37	-0.59	-1.22
30 seconds	0.66	0.80	0.38	-0.71	-1.08

Note: Proportions and numbers of videos averaged across 5 experimental trials
Term. Downloads (proportion) = the proportion of videos terminated during the download time of the total number of videos queued to load (per trial)
Videos Finished = the number of videos finished (watched to the end) (per trial)
Videos Finished (proportion) = the proportion of videos finished (watched to the end) of videos started (per trial)
Videos Started = the number of videos started after the download time

We again conducted Spearman rank-order correlations among our dependent variables for the 5-second, 15-second and 30-second download times. The correlations are presented in Table 4. Again, the correlations varied widely, but none of the correlations were equal to 1, indicating that the measures were not completely redundant.

Table 4

Correlations of dependent variables for experiment two (N=91)

	1	2	3	4
5-second download time				
1. Proportion of terminated downloads		-.07	-.04	-.03
2. Number videos Started			-.23*	-.55**
3. Number videos finished				.83
4. Proportion of videos finished				
15-second download time				
1. Proportion of terminated downloads		.09	-.04	-.07
2. Number videos Started			-.20	-.56**
3. Number videos finished				.79**
4. Proportion of videos finished				
30-second download time				
1. Proportion of terminated downloads		-.40**	-.33*	.02
2. Number videos Started			-.08	-.53**
3. Number videos finished				.75**
4. Proportion of videos finished				

** p < .001, * p < .05

Proportion of Terminated Downloads. The results of a Friedman test revealed there was a statistically significant difference across the three download time conditions (5-, 15- & 30-seconds) in the proportion of videos terminated during the download ($x^2(2) = 21.93$, $p < .001$; see Figure 5). Post-hoc Wilcoxon signed-rank tests indicated that there were significantly more download terminations of videos with a 30-second than a 5-second download time, $p <.001$, $r = -0.30$. There were also significantly more terminations during the download time for videos with a 30-second than a 15-second download time, $p < .001$, $r = -0.30$. There was no significant difference in the download time terminations for videos with a 15-second and a 5-second download time, $p = .228$, $r = -0.09$.

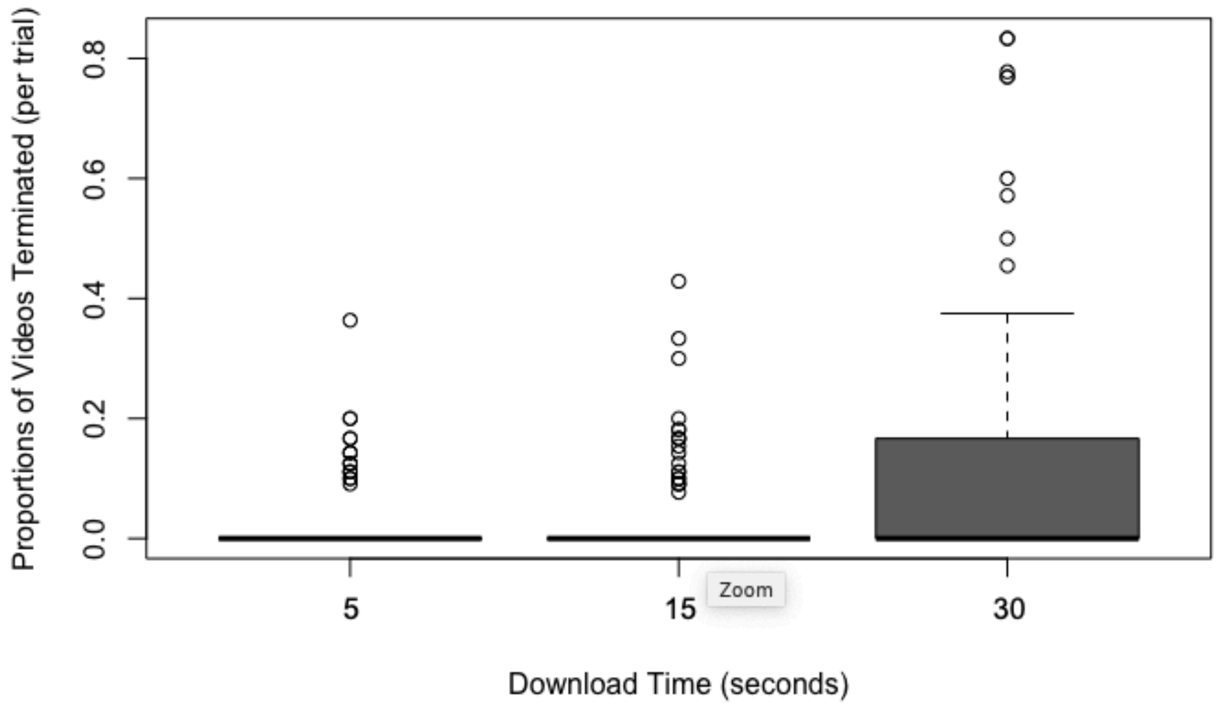

Figure 5. Box and whisker plots (boxplots) of the proportion of videos terminated during the download time as a function of the download time.

Again here, we analyzed the total number of videos queued, which served as the denominator in the calculation of the proportion of terminated downloads measure, and found it differed across download conditions ($x^2(2) = 10.44$, $p = .005$). Though, when we look at the number of first clicks on videos (i.e., to measure whether participants are disproportionately initially clicking on videos with a 30-second download time), there was no significant difference between download times ($x^2(2) = 3.01$, $p = .222$). Therefore, as in Experiment 1, the greater number of clicks observed on the 30-second download time videos was due to participants terminating the download, queuing another video, and then returning to the save video with the 30-second download at later time in the trial and queuing that video to load an additional time.

Further, since we examined the proportion of terminated downloads for videos with a 30-second download time in both Experiment 1 and Experiment 2, we can compare the rates of terminated downloads for videos with a 30-second download time in the context of more similar (Experiment 2) and dissimilar (Experiment 1) download times. Wilcoxon signed-ranked tests indicated participants terminated significantly more 30-second download times in Experiment 1 than Experiment 2 (p <.001, r = -0.58), with participants terminating 54% of videos queued to download with a 30-second download time in Experiment 1 and just 12% of queued to download videos with a 30-second download time in Experiment 2.

Number of Videos Started. There was an approximately equal number of videos started across the three download times (see Figure 6). This was confirmed by a Friedman test, which showed there was no statistically significant effect of download time on the number of videos started, $x^2(2) = 1.80$, $p = 0.407$.

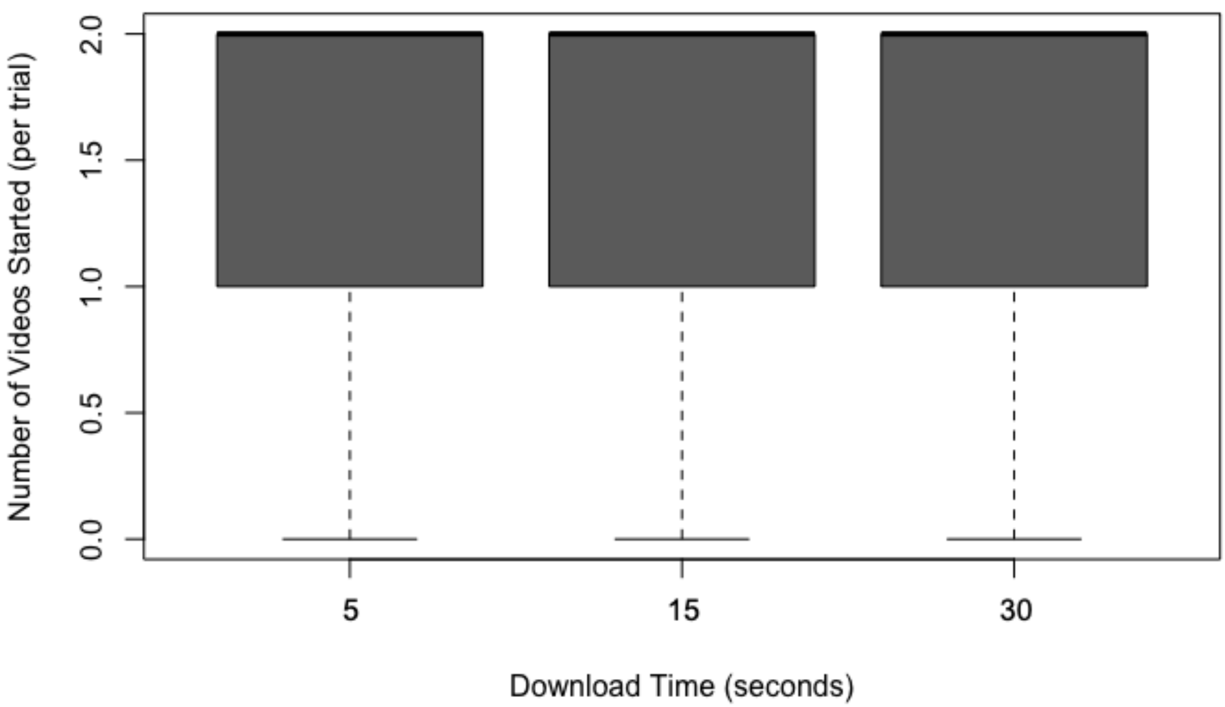

Figure 6. Box and whisker plots (boxplots) of the number of videos started as a function of the download time.

Number of Videos Finished. Applying the Friedman test, we found the number of videos finished did not significantly differ across the three download time conditions (5, 15, and 30 seconds), $x^2(2) = 1.09$, $p = 0.581$ (see Figure 7A).

Proportion of Videos Finished. Figure 7B shows the proportion of videos finished (number of videos finished as a function of the number of videos started) in the three download conditions. Inspection of the figure reveals approximately equal proportions of videos finished across the three download times. This observation was confirmed by a Friedman test showing no statistically significant effect of download time on the proportion of videos finished, $x^2(2) = 2.54$, $p = 0.281$.

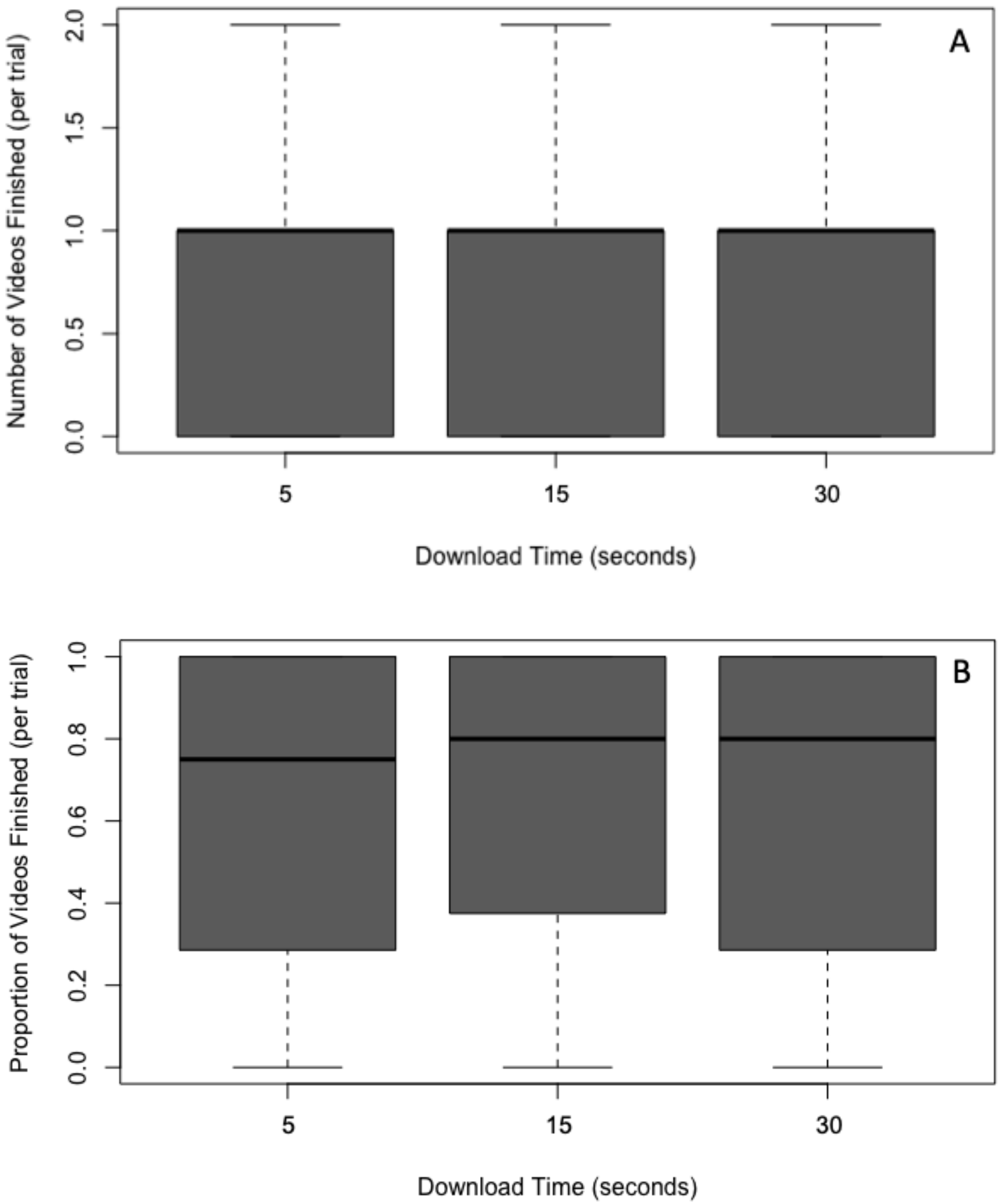

Figure 7. Box and whisker plots (boxplots) of the number of videos finished (A); and as a proportion of videos stared (B) as a function of the download time.

Motivation. We again found there were some significant correlations between our video watching measures of interest and self-reported motivation (see Supplementary Materials in Appendix D).

End of Session Strategy Sheet. Four participants (0.04%) noted a difference in download times between videos, and no participants reported they suspected the differences in download time were intentional. The remaining participants indicated they moved through the videos either by watching the videos that interested them or by watching a certain time period of each video enabling them to watch at least a small portion of each video.

End of Session Quiz. Quiz performance was again near ceiling and so we did not analyze it in relation to our video watching variables of interest. On average participants answered 90% of questions correctly, with scores ranging from 70-100%.

Discussion

As in Experiment 1, the results of Experiment 2 demonstrate that people abandon more long downloads and shift to information that will potentially load in less time. However, in contrast to Experiment 1, in Experiment 2 (when using a different set of download times), we found that participants started and finished an equal proportion of videos regardless of the download time. One obvious question that emerges from this pattern of findings is why participants terminate more 30-second downloads than 5- or 15-second ones, but still start and finish an equal proportion of videos associated with the 30-second download as those associated with faster downloads? One possible explanation is that participants simply re-click (to re-queue) videos that seem to take a long time to download. Such a behavior would lead to more re-clicks on videos associated with a 30-second download time than on videos associated with a shorter download time without influencing how many times a video starts to play or how long it is ultimately watched.

It is worth noting that the results of Experiment 2 differed from Experiment 1 in another interesting way. Specifically, participants terminated significantly *fewer* 30-second downloads in Experiment 2 (about 12%) than in Experiment 1 (about 54%). One explanation for this difference is that participants experienced the download times included in Experiment 2 (5, 15, & 30 seconds) as being quite similar and generally 'slow' whereas participants experienced the downloads in Experiment 1 (0, 2, & 30 seconds) as being relatively more heterogenous, with the 30-second download time as being particularly slow relative to the other download times. This may have in turn led participants in Experiment 2 to be more tolerant of the 30-second download time than the participants in Experiment 1.

General Discussion

The primary goal of the two experiments reported in this paper was to evaluate whether increasing the download time of (simulated) online videos would discourage participants from accessing the content in those videos. In Experiment 1, we found participants terminated more downloads, and started and finished fewer videos with a 30-second download time than videos with shorter 0- or 2-second download times. These results suggest that increasing the download time of online content will, under at least some conditions, discourage engagement with the content.

However, the results of Experiment 2 led to a more nuanced and complex conclusion. Compared to Experiment 1, in Experiment 2, we included more homogeneous and generally longer download times and found that while participants continued to terminate more 30-second downloads relative to the shorter downloads (15- and 5-seconds), participants started and finished an equal number of videos regardless of the download time. Also, participants tolerated more of the 30-second downloads when the download times were slower and more homogenous (Experiment 2) than when they more heterogeneous and overall faster (Experiment 1). This suggests that as download times become more similar (and slow), participants become less likely to choose content based on download time and are not as discouraged by the slower download times in the session. Participant responses on the strategy sheets support this conclusion: 40% of participants in Experiment 1 noted the differences in download times, while only a handful (less than 1%) of participants noted that same difference in Experiment 2. This supports the explanation that participants perceived the download times to be more similar in Experiment 2 than in Experiment 1. Thus, when the results of Experiments 1 and 2 are considered together, it becomes clear that whether variations in download times of content influence engagement with the content depends on contextual factors, with one of these factors being the specific variety of download times available in a given search session.

Our findings may provide one plausible explanation for why prior studies of 'tolerable' or 'acceptable' download times have led to widely varying estimates, ranging from 4 seconds to 41 seconds (Galletta et al. 2002; Galletta et al., 2006; Hoxmeier & DiCeare 2000; Ramsey et al. 1998; Nah 2004). Specifically, our findings suggest that the dramatic variation in tolerable wait time estimates may be partly due to variations in contextual factors across studies. That is, the variance in estimates might have emerged because (1) studies may have varied in terms of the variety of download times made available to participants and (2) different samples of participants might have had very different experiences with download times in their everyday lives.

In light of our findings it would seem reasonable for future investigations to focus on exploring other contextual factors that might influence the impact of download times on engagement with the content associated with those download times. One example of such a contextual factor might be time pressure. In our studies, participants completed trials with a 5-minute time limit and it would be interesting to examine whether removing the time limit would change the relation between download time and engagement with the corresponding content. Another example of a potentially important contextual factor is the presence of 'information scents', such as an indication of the source of the content. It could very well be that people are willing to endure much longer download times to access information sources they deem more valid or those they think will provide information consistent with their worldview (due to confirmation bias; Nickerson, 1998).

Future research might also focus on exploring how barriers to information access other than download time influence information access. For example, it would be interesting to know how down-ranking of information affects information access by influencing 'informational scent' cues (in the language of information foraging theory). That is, down-ranked information may be perceived as being less valuable (or less pertinent), thus discouraging access. Alternatively, down-ranking might simply make it less likely that the information will come into view. Regardless, given the admitted use of down-ranking by social media platforms (e.g., twitter; Newton, 2018), this form of manipulating information access ought to be examined further. On a broader note, understanding the various factors that govern information access online will be quintessential as society navigates the various complexities of this mass communication tool we call the internet.

References

Bernays, E. L. (1937). *Propaganda*. Ig publishing.

Bast, A. & Campanile, G. (Producer). (April 9, 2017) Brain Hacking [Television series episode]. In *60 Minutes*. CBS News.

Chomsky, N. (2002). *Media control: The spectacular achievements of propaganda* (Vol. 7). Seven Stories Press.

Collins, K. (2018). Net Neutrality Has Officially Been Repealed. Here's How That Could Affect You. Retrieved March 7, 2019 from https://www.nytimes.com/2018/06/11/technology/net-neutrality-repeal.html.

Dennis, A. R., & Taylor, N. J. (2006). Information foraging on the web: The effects of "acceptable" Internet delays on multi-page information search behavior. *Decision Support Systems*, *42*(2), 810–824. https://doi.org/10.1016/j.dss.2005.05.032

DiClemente, D. F., & Hantula, D. A. (2003). Optimal Foraging Online: Increasing Sensitivity to Delay. *Psychology and Marketing*, *20*(9), 785–809. https://doi.org/10.1002/mar.10097

Fu, W.T., & Pirolli, P. (2007). Human-Computer Interaction SNIF-ACT: A Cognitive Model of User Navigation on the World Wide Web. *Human-Computer Interaction*, *22*, 355–412. https://doi.org/10.1080/07370020701638806

Galletta, D., Henry, R., McCoy, S., & Polak, P. (2002). Web site delays: How slow can you go? *First Annual Pre-ICIS Workshop on HCI Research in MIS*, 14 December 2002 (Barcelona, Spain: AIS Special Interest Group on Human Computer Interaction).

Galletta, D.F., Henry, R.M., McCoy, S., Polak, P. (2006). When the wait isn't so bad. *Information Systems Research*, *17*, 20–37.

Hoxmeier, J. A. & DiCesare, C. (2000). System response times and user satisfaction: An experimental study of browser-based applications, *Americas Conference on Information Systems*. Long Beach, CA, USA, August 10-13 2000.

Kharif, O. (2018). YouTube, Netflix Videos Found to Be Slowed by Wireless Carriers. Retrieved March 7, 2019 from https://www.bloomberg.com/news/articles/2018-09-04/youtube-and-netflix-throttled-by-carriers-research-finds.

Kline, R.B. (1998). *Principles and practice of structural equation modeling* (2nd ed.). Guilford, New York, NY.

Schwartz, M. S. (2019). Facebook Bans Alex Jones, Louis Farrakhan And Other 'Dangerous' Individuals. Retrieved May 16, 2019 from https://www.npr.org/2019/05/03/719897599/facebook-bans-alex-jones-louis-farrakhan-and-other-dangerous-individuals.

Lippmann, W. (1922). *Public opinion.* Routledge.

Lippmann, W. (1925). The phantom public. Routledge.

Liu, X., Chin, J., Payne, B. R., Fu, W.-T., Morrow, D. G., & Stine-Morrow, E. A. L. (2016). Adult age differences in information foraging in an interactive reading environment. *Psychology and Aging*, *31*(3), 211–223. https://doi.org/10.1037/pag0000079

Newton, C. (2018). Twitter will hide more bad tweets in conversations and searches. Retrieved April 25, 2019 from https://www.theverge.com/2018/5/15/17352962/twitter-abuse-changes-ranking-tweets-conversations-search.

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*(2), 175-220.

Nowak, P. (2008). Bell sued for throttling internet speeds. Retrieved March 7, 2019 from https://www.cbc.ca/news/technology/bell-sued-for-throttling-internet-speeds-1.713254.

Rogan, J. (Producer). (2019, February 1). *#1236 – Jack Dorsey* [Audio podcast]. Retrieved from Apple Podcasts.

Pirolli, P. (2005). Rational analyses of information foraging on the web. *Cognitive Science*, *29*(3), 343–373. https://doi.org/10.1207/s15516709cog0000_20

Pirolli, P., & Card, S. (1999). Information Foraging. *Psychological Review*, *106*(4), 643–675. Retrieved from http://psycnet.apa.org/fulltext/1999-11924-001.pdf

Pirolli P., and Fu W.T. (2003) SNIF-ACT: A Model of Information Foraging on the World Wide Web. *Lecture Notes in Computer Science*, 2702.

Rajala, A. K., & Hantula, D. A. (2000). Towards a behavioral ecology of consumption: Delay reduction effects on foraging in a simulated online mall. *Managerial and Decision Economics*, *21*, 145–158.

Ramsay, J., Barbesi, A., & Preece, J. (1998). A psychological investigation of long retrieval times on the world wide web. *Interacting with Computers* 10, 77-86. Retrieved from https://academic.oup.com/iwc/article-abstract/10/1/77/913206

Rose, G. M., Lees, J., & Meuter, M. L. (2001). A refined view of download time impacts on e-consumer attitudes and patronage intentions toward e-retailers. *International Journal on Media Management* 3:2, 105-111.

Appendix A

Experimental Videos:

Atler, A. (2017, April). Why our screens make us less happy [Video file; 4:23-5:20]. Retrieved from https://www.ted.com/talks/adam_alter_why_our_screens_make_us_less_happy.

Achor, S. (2011, May). The happy secret to better work [Video file; 7:40-8:34]. Retrieved from https://www.ted.com/talks/shawn_achor_the_happy_secret_to_better_work.

Atala, A. (2009, October). Growing new organs [Video file; 0:59-2:06]. Retrieved from https://www.ted.com/talks/anthony_atala_growing_organs_engineering_tissue.

Autor, D. (2016, September). Will automation take away all our jobs? [Video file; 0:12-1:22]. Retrieved from https://www.ted.com/talks/david_autor_why_are_there_still_so_many_jobs

Bourelle, J. S. (2015, July). How culture drives behaviours [Video file; 5:32-6:40]. Retrieved from https://www.youtube.com/watch?v=l-Yy6poJ2zs.

Burchat, P. (February 2008). Shedding light on dark matter [Video file; 0:47-1:48]. Retrieved from https://www.ted.com/talks/patricia_burchat_leads_a_search_for_dark_energy.

Cain, S. (2012, February). The power of introverts [Video file; 4:08-5:08]. Retrieved from https://www.ted.com/talks/susan_cain_the_power_of_introverts.

Chatterjee, A. (2016, November). How your brain decides what is beautiful [Video file; 11:45-12:41]. Retrieved from https://www.ted.com/talks/anjan_chatterjee_how_your_brain_decides_what_is_beautiful.

Cliff, H. (2015, December). Have we reached the end of physics? [Video file; 9:23-10:27]. Retrieved from https://www.ted.com/talks/harry_cliff_have_we_reached_the_end_of_physics.

Conley, C. (2010, February). Measuring what makes life worthwhile [Video file; 2:59-4:01]. Retrieved from https://www.ted.com/talks/chip_conley_measuring_what_makes_life_worthwhile.

Cuddy, A. (2012, June). Your body language may shape who you are [Video file]. Retrieved from https://www.ted.com/talks/amy_cuddy_your_body_language_shapes_who_you_are.

Ferriss, T. (2017, April). Why you should define your fears instead of your goals [Video file; 2:57-4:01]. Retrieved from https://www.ted.com/talks/tim_ferriss_why_you_should_define_your_fears_instead_of_your_goals.

Foss, A. (2016, February). A prosecutor's vision for a better justice system [Video file; 8:37-9:38]. Retrieved from https://www.ted.com/talks/adam_foss_a_prosecutor_s_vision_for_a_better_justice_system.

Genova, L. (2017, April). What you can do to prevent Alzheimer's [Video file; 1:34-2:41]. Retrieved from https://www.ted.com/talks/lisa_genova_what_you_can_do_to_prevent_alzheimer_s.

Gilbert, E. (2009, February). Your elusive creative genius [Video file; 8:09-9:15]. Retrieved from https://www.ted.com/talks/elizabeth_gilbert_on_genius.

Hajek, L. (2014, March). What rives can tell us about the earth's history [Video file; 6:49-7:57]. Retrieved from https://www.ted.com/talks/liz_hajek_what_rivers_can_tell_us_about_the_earth_s_history.

Herr, H. (2014, March). The new bionics that let us run, climb and dance [Video file; 5:33-6:41]. Retrieved from https://www.ted.com/talks/hugh_herr_the_new_bionics_that_let_us_run_climb_and_dance.

Kalanick, T. (2016, February) Uber's plan to get more people into fewer cars [Video file; 3:18-4:24]. Retrieved from https://www.ted.com/talks/travis_kalanick_uber_s_plan_to_get_more_people_into_fewer_cars.

Kim, G. (2017, April). How cohousing can make us happier (and live longer) [Video file; 7:27-8:23]. Retrieved from https://www.ted.com/talks/grace_kim_how_cohousing_can_make_us_happier_and_live_longer.

Kundu, A. (2017, June). The boost students need to overcome obstacles [Video file; 2:36-3:43]. Retrieved from https://www.ted.com/talks/anindya_kundu_the_boost_students_need_to_overcome_obstacles.

Li, W. (2010, February) Can we eat to starve cancer? [Video file; 0:18-1:25]. Retrieved from https://www.ted.com/talks/william_li.

McGonigal, K. (2013, July). How to make stress your friend [Video file; 1:52-2:56]. Retrieved from https://www.ted.com/talks/kelly_mcgonigal_how_to_make_stress_your_friend.

MacGregor, N. (2011, July) 2600 years of history in one object [Video file; 0:16-1:18]. Retrieved from https://www.ted.com/talks/neil_macgregor_2600_years_of_history_in_one_object.

Meyer, P. (2011, July). How to spot a liar [Video file; 1:51-2:49]. Retrieved from https://www.ted.com/talks/pamela_meyer_how_to_spot_a_liar.

Ronald, P. (2015, March). The case for engineering our food [Video file; 3:53-4:58]. Retrieved from https://www.ted.com/talks/pamela_ronald_the_case_for_engineering_our_food.

Schwartz, B. (2005, July). The paradox of choice [Video file; 8:03-9:07]. Retrieved from https://www.ted.com/talks/barry_schwartz_on_the_paradox_of_choice.

Sinek, S. (2009, September). How great leaders inspire action [Video file; 2:23-3:18]. Retrieved from https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action.

Smith, A. (2016, April). Why you should love statistics [Video file; 1:36-2:42]. Retrieved from https://www.ted.com/talks/alan_smith_why_we_re_so_bad_at_statistics.

Stafford, K. (2016, November). How human noise affects ocean habitats [Video file; 2:44-3:38]. Retrieved from https://www.ted.com/talks/kate_stafford_how_human_noise_affects_ocean_habitats.

Zomorodi, M. (2017, April). How boredom can lead to your most brilliant ideas [Video file; 2:51-4:01]. Retrieved from https://www.ted.com/talks/manoush_zomorodi_how_boredom_can_lead_to_your_most_brilliant_ideas.

Appendix B

Video Viewing Task Instructions:

[Instructions were provided to participants verbally prior to beginning the task.]

During this experiment, you will have the opportunity to watch up to 30 videos over 5 experimental ‘blocks’. Each block will contain 6 video clips and be 5 minutes in length. Try to watch as many videos as you can. There is a clock in the upper left corner of the screen, so you can monitor the time remaining in each block. There will be a comprehension test at the end of the experiment to assess your knowledge of video content. You can watch the videos in any order and you are in control of starting, stopping, or switching between the videos at any time. After you click on each video, there may be a short delay as it loads and then it will play. However, only one video will load or play at a time. After 5 minutes has elapsed, any video you are playing and/or loading will automatically stop and you will be given a short break before the next block begins.

When the computer program ends, please fill out the sheet that is face down on your desk.

When the experiment is over, we will wait for everyone to finish so participants still working are not disrupted.

Motivation Question:

[Participants indicated their motivation on the 1-7 with a key press.]

How motivated were you to watch as many videos as you could?

1) Not motivated at all
2)
3)
4)
5)
6)
7) Extremely motivated

Strategy Sheet:

[Participants provided their answers by hand.]

Please describe any strategies you used when viewing videos:

Appendix C

End of Session Quiz:

[Questions were presented one at a time and appeared in a random order for each participant.]

The comprehension test will consist questions based on video content you just had the opportunity to view. All 30 questions are TRUE / FALSE.

1. Since the introduction of the automated teller machine (ATM) the number of bank tellers in the US has increased. [Autor]
2. Research has shown boards composed of different cultures perform worse than those composed of only one culture. [Bourrelle]
3. Researchers have demonstrated individuals with facial abnormalities are thought to be less kind and less hard working. [Chatterjee]
4. We can test the idea of the multiverse, so we are reasonably certain it exists. [Cliff]
5. Maslow wanted his hierarchy of needs to be applied to the collective as well as the individual. [Conley]
6. There was an argument made by one of the speakers that it was a mistake for individuals to begin thinking they *are* a genius instead of *having* a genius. [Gilbert]
7. Capillaries (tiny blood vessels) cannot adapt to the environment (liver, lungs, muscle etc.) they're growing in. [Li]
8. The main object of discussion in one of the videos was the shape of a rugby ball and made approximately 2500 years ago. [MacGregor]
9. When individuals are presented with more choices, they find it easier to make a choice. [Schwartz]
10. "Inspired" corporations think from the inside out (why, how, what) versus from the outside in (what, how, why). [Sinek]
11. Individuals spend a greater amount of time on the apps that make them happy than the ones that make them unhappy. [Atler]
12. The synapse is where Alzheimer's happens. [Genova]
13. Individuals who are blind display a different physical expression of victory than those with sight. [Cuddy]
14. When looking at the components of the universe, ordinary matter makes up the smallest proportion of the universe. [Burchat]
15. When studying the Earth's history, there is nothing in our current environment that allows us to look back on the landscapes of the past. [Hajek]
16. When examining rates of low numeracy around the world, the Netherlands and Korea have the lowest percentages of their populations with low numeracy. [Smith]
17. In ocean habitats, marine mammals see using light under water. [Stafford]
18. When you share meals with your neighbours, you start to plan more activities together and share more things. [Kim]
19. In the US, millions of hours a year are wasted sitting in traffic. [Kalanick]
20. Stoicism involves training yourself to separate what you can control from what you cannot control. [Ferriss]
21. Introversion and being shy are the same thing. [Cain]

22. Researchers have shown that your external circumstances predict only a small amount of your long-term happiness. [Achor]
23. Most rice varieties will die if submerged in water for more than 1 day. [Ronald]
24. To overcome their circumstances, the examples in the video had both grit and agency. [Kundu]
25. Lying is a solo act. [Meyer]
26. Studies have shown the belief that stress was bad for you leads to an increased risk of death. [McGonigal]
27. Studies have shown the activation of the brain's default mode network is not related to boredom. [Zomorodi]
28. One patient dies from a disease that could be treated using tissue replacement every 30 seconds. [Atala]
29. There was no mathematical modeling used in the design and attachment of the speaker's bionic limbs. [Herr]
30. Prosecutors cannot be told how to prosecute their cases. [Foss]

Appendix D

Experiment One

We were also interested in the correlation between our measures of interest and participants' self-reports of motivation at the end of the experiment. Participants were asked to rate how motivated they were to watch as many videos as possible. This was done using a scale ranging from 1 to 7 (1 = not motivated at all, 7 = extremely motivated). Since some of our measures were had non-normal distributions, we conducted a Spearman's Rank Order Correlation for each measure of interest and participants' self-reports of motivation.

Overall, participants rated being reasonably motivated to watch as many videos as possible with a mean motivation of 5.30.

Proportion of terminated downloads. As presented in Table A1, there were no significant relations between participants' self-reports of motivation and the proportion of terminated downloads for any download time.

Number of videos started. As presented in Table A1, there was a significant relation between self-reports of motivation and the number of videos started with a 0-second download time, $r(97) = .23$, $p = .024$, and the number of videos started a 2-second download time, $r(97) = .26$, $p = .011$. There was not a significant relation between self-reports of motivation and the number of videos that started with a 30-second download time, $r(97) = .-10$, $p = .305$.

Number of videos finished. As presented in Table A1, there was not a significant relation between self-reports of motivation and the number of videos finished with a 0-second download time, $r(97) = .07$, $p = .513$, and the number of videos finished with a 2-second download time, $r(97) = .10$, $p = .322$. There was a significant relation between self-reports of motivation and the number of videos finished with a 30-second download time, $r(97) = -.25$, $p = .012$. Those who are more motivated, finish significantly fewer videos with a 30-second download time.

Proportion of videos finished. As presented in Table A1, there were no significant relations between self-reported motivation and the proportion of videos finished. However, the relation between the motivation and the proportion of videos finished with a 30-second download time approached significance, *r*(97) = -.28, *p* = .054.

Table A1. Spearman rank order correlation between key measures and motivation by download time.

Download Time	Proportion of terminated downloads	Number of videos started	Number of videos finished	Proportion of videos finished
0 seconds	-.17	.23*	.07	-.02
2 seconds	-.10	.26**	.10	-.01
30 seconds	.06	-.10	-.25*	-.28

Note. Correlation coefficients are rounded to two decimal places.
* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

Experiment Two

Participants in Experiment Two were presented the same motivation question as in Experiment One. Since again some of our measures were had non-normal distributions, we conducted a Spearman's Rank Order Correlation for each measure of interest and participants' self-reports of motivation.

Overall, participants in Experiment two also rated being reasonably motivated to watch as many videos as possible with a mean motivation of 5.23.

Proportion of terminated downloads. As presented in Table A2, there were no significant relations between participants' self-reports of motivation and the proportion of terminated downloads for any download time.

Number of videos started. There was not significant relation between self-reports of motivation and the number of videos started with a 5-second download time, *r*(89) = .19, *p* = .065, nor the number of videos started a 30-second download time, *r*(89) = .-.09, *p* = .371. There was however, a significant relation between self-reports of motivation and the number of videos that started with a 15-second download time, $r(89) = .29$, $p = .004$. More motivated participants finished more videos with a 15-second download time (Table A2).

Number of videos finished. There was not a significant relation between self-reports of motivation and the number of videos finished with a 5-second download time, $r(89) = -.07$, $p = .527$, nor the number of videos finished with a 15-second download time, $r(89) = -.07$, $p = .489$. There was a significant relation between self-reports of motivation and the number of videos finished with a 30-second download time, $r(89) = -.29$, $p = .006$. Such that, those who are more motivated, finish significantly fewer videos with a 30-second download time (Table A2).

Proportion of videos finished. As presented in Table A2, there were no significant relations between self-reported motivation and the proportion of videos finished.

Table A2. Spearman rank order correlation between key measures and motivation by download time.

Download Time	Proportion of terminated downloads	Number of videos started	Number of videos finished	Proportion of videos finished
5 seconds	-.02	.19	-.07	-.06
15 seconds	.17	.29**	-.07	-.15
30 seconds	.19	-.09	-.29**	-.14

Note. Correlation coefficients are rounded to two decimal places.
* Correlation is significant at the .05 level
** Correlation is significant at the .01 level