

# **The Effects of Pagination and Infinite Scrolling on Leisure Browsing**

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## **Abstract**

This experiment investigates the effect of webpage content displayed on discrete pages versus an infinitely scrolling page on users' recollection of content and browsing satisfaction. To explore this effect, we had 21 participants view captioned images on one of two Tumblr blogs: one containing ten entries per page and the other presenting all of the entries on one page. We found no statistically significant difference between the paginated and infinite scrolling blogs for either browsing satisfaction or content recall; however, our experiment suffered from low statistical power because of the small number of participants. Our study provides a framework for other researchers to explore the relationship between page layout and web browsing user experience.

## **Introduction**

The rapid growth in the amount of media posted on the Internet presents designers with new challenges for how to best present this content. One recent trend for presenting large amounts of content is using web pages that scroll infinitely. An infinitely scrolling page dynamically loads new content at the bottom of the page, so users can browse through what would have previously been many pages of content without ever having to advance to a new web page on their own.

Major websites like Twitter, Tumblr, Facebook, Google, Pinterest, and Etsy have all experimented with infinitely scrolling interfaces in recent years. Searches for the phrase "infinite scroll" on Google have dramatically increased over the past two years (Google n.d.). For ecommerce sites and sites relying on ad revenue, infinite scrolling may encourage users to spend more time discovering and engaging with site content, which could lead to higher revenue (Richard, 2005). Nevertheless infinite scrolling may not be appropriate for all types of content and websites.

Despite the recent popularity of infinitely scrolling websites, the technology industry has started considering some of the potential drawbacks of this layout technique. *Smashing Magazine* published an article in 2013 about infinite scroll where they aimed to discover its strengths and weaknesses. In this article, Yogev Ahuvia argues that infinite scroll prevents users from determining exactly where they are on a web page, a situation that could lead to users feeling lost and frustrated. A never-ending list of results could overwhelm users and cause them to waste time searching far beyond where they would have given up on a normal paginated results set. However, Ahuvia states that infinite scrolling can be an effective and efficient way to deliver large amounts of content in real time, and it can reveal content that users might have otherwise overlooked.

In another blog post about infinite scroll, Dan Nguyen (2013) details Etsy's failed implementation of infinite scroll, as informed by Dan McKinley, Principal Engineer at Etsy. Nguyen reveals that Etsy's attempt at infinite scroll had a negative impact on user engagement by decreasing the number of items that users clicked on or favorited from the search results page. Nguyen argues that this failure was based on Etsy's blind acceptance of the concepts that infinite scroll is predicated on, "Users want more results per page. Users want faster results," and that Etsy should have tested these assumptions

before implementing a design based on them.

Both Nguyen and Ahuvia bring up relevant issues about infinite scroll, but they primarily present heuristics and speculation not backed by empirical evidence. A number of formal research studies have investigated the relationship between paging and scrolling for relatively limited amounts of content, but none of the studies investigated infinitely scrolling web pages (Baker, 2003; Eyuboglu & Orhan, 2009; Peytchev et al., 2006). By conducting experimental research on infinite scroll, we hoped to provide empirical evidence about the effectiveness of this content presentation technique compared to the effectiveness of pagination as a method for engaging users.

### *Research Statement*

This study investigates the effect of infinite scroll versus pagination on participants' image recollection and browsing experience satisfaction on Tumblr blogs. Tumblr is one of the pioneers of the infinitely scrolling layout, and Tumblr also allows users to select between infinitely scrolling designs and paginated designs for their personal blogs; therefore, we saw it as a fitting site to use for this experiment.

### *Overview*

This paper contains a description of our experiment testing infinite scroll and pagination. We start by considering past work and situating our experiment within the larger research community. We then detail the setup of our study, describing the experimental conditions and participants. Following the description of our methods, we present our results and explore their significance. We conclude by suggesting extensions of our work and identifying limitations of our study.

## **Literature Review**

### *Previous studies on pagination and scrolling*

The current state of the literature on the influence of pagination versus scrolling has yielded conflicting findings depending on text length and text content type. Eyuboglu and Orhan (2009) found that studies conducted prior to 2000 indicated that short pages were better than long scrolling pages, whereas after 2000, studies indicated that longer pages were preferable. Earlier studies that favored paging, such as Piolat et al.'s (1997), focus heavily on the notion of the computer screen as a metaphor for paper, which gradually became less important as users became more familiar with computers and the notion of scrolling. Eyuboglu and Orhan (2009), Peytchev et al. (2006), and Baker (2003) all found no significant difference between paginated and scrolling layouts for factors such as satisfaction, comprehension, and perception of site efficiency, but Sanchez and Wiley (2009) found that "scrolling negatively affects learning from text, and this effect is most pronounced in learners who have lower working memory capacity."

### *Limitations*

These studies possessed a limited scope because of the type of text studied as well as their focus on short-term memory recall. Much of the literature on the influence of pagination and scrolling on textual comprehension and within document navigation has focused on educational hypertext from textbooks or research journal articles. Studies have also focused on pagination's influence on the

amount of time it takes for participants to read, as well as textual recall and comprehension. Sanchez & Wiley (2009) critiqued the literature on pagination and scrolling for focusing on short-term recall of the text and quizzing participants about specific facts, rather than asking them about their global comprehension of the text. We were unable to find any studies about pagination and scrolling on longer-term recall, so it is unknown if page layout affects people's ability to remember text content even a week after reading it.

### *User Gratification*

Previous studies looking at scrolling and pagination mainly focused on the impact for time on task and comprehension. User satisfaction and other subjective measures of user perception of the material are rarely taken into account; the study by Baker (2003) was the only one we found that included these measures. Since infinite scrolling is used on sites such as Tumblr and Pinterest, which are commonly accessed for entertainment browsing, it warrants exploring the connection between user satisfaction and browsing behavior.

Zhang and Zhang (2013) attempted to link the two concepts of satisfaction and browsing behavior for users reading online news. Taking a cue from media studies, they referenced the uses and gratifications (U&G) approach, which suggests that gratification can predict media usage. They also cite that gratification can be experienced through both content and the medium. They established that there are two main concepts in gratification: gratification from usage experience and gratification from information utility. Usage experience gratification refers to the immediate effect, such as getting lost in the content. Information utility gratification is delayed, such as checking the weather when deciding to bring an umbrella. To fill in the dearth of literature on pagination and scrolling's influence on the more holistic, non-task driven user experience, our study included measures of users' subjective experiences and satisfaction while browsing.

### *Image Search and Browsing*

Given the plethora of image, audio, and visual media available for discovery and consumption online, as well as the increased presence of infinite scrolling on image-heavy sites, we hoped to fill in the gaps in the literature of pagination and scrolling's effect on image searching and browsing. We were unable to find any studies investigating pagination and scrolling's effects on image searching and browsing, but the literature does suggest that image searching and browsing behavior tends to be driven by user gratification, rather than from a stricter task-oriented motivation. Andre et al. (2009) found that image-based search differs from text-based search in three primary ways: greater use of search for entertainment purposes, more emphasis on resource gathering, and greater use of query reformulation.

### *Taskonomy of Web Use*

As mentioned, previous research investigating scrolling has focused on task-based behaviors; however, users browse the Internet for a variety of reasons. Byrne et al. (1999) established a "taskonomy" of web use, dividing Internet usage into six general classes of tasks: Use Information, Locate on Page, Go to Page, Provide Information, Configure Browser, and React to Environment. Grouping different user actions can help focus the attention of our research since infinite scroll may be a useful interface for some browsing behaviors but not others. Byrne et al. found that users spent

the most time using information and less time on functional tasks. In terms of volume, users engaged in scrolling as a frequent task. Their research suggested that because users “spend a great deal of time scrolling ... advances which reduce the latency of scroll operations ... have the potential to save users considerable time” (Byrne et al., 1999, p. 550). This is why the focus of our study will be on browsing the web for leisure as opposed to task-based browsing.

### *Hypothesis*

For this experiment, we studied how the independent variable of page layout (pagination versus infinite scrolling) affects the dependent variables, participants’ image recollection and browsing satisfaction. We defined a paginated blog as one containing 10 entries per page, and an infinitely scrolling blog as one with all of the content displayed on one long page, where new content loads as the user scrolls. We defined the participants’ image recollection as how many images they remembered that were displayed on the Tumblr, as measured by a quiz. We defined browsing satisfaction as how much the participants enjoyed viewing the blog, as measured by self-report Likert-scale questions.

We predicted that participants would have an easier time remembering the items that they viewed on the paginated blog, based on findings from Sanchez & Wiley (2009) about memory, but they would enjoy the experience of browsing more on an infinitely scrolling blog, based on findings from Zhang & Zhang about gratification (2013).

## **Methods**

### *Participants*

We recruited 30 participants, who were familiar with Tumblr, through convenience sampling. We randomly assigned the participants to the infinite scrolling and paging conditions, with 15 participants in each group. Ten participants in the paginated condition and 12 participants in the scrolling condition completed the experiment; however, we eliminated one participant in the paginated condition because of a problem with the recall responses. We ended up with 21 participants, 9 male and 12 female. The participants ranged in age from 14 to 45, with an average age of 27. All participants completed the entirety of the study.

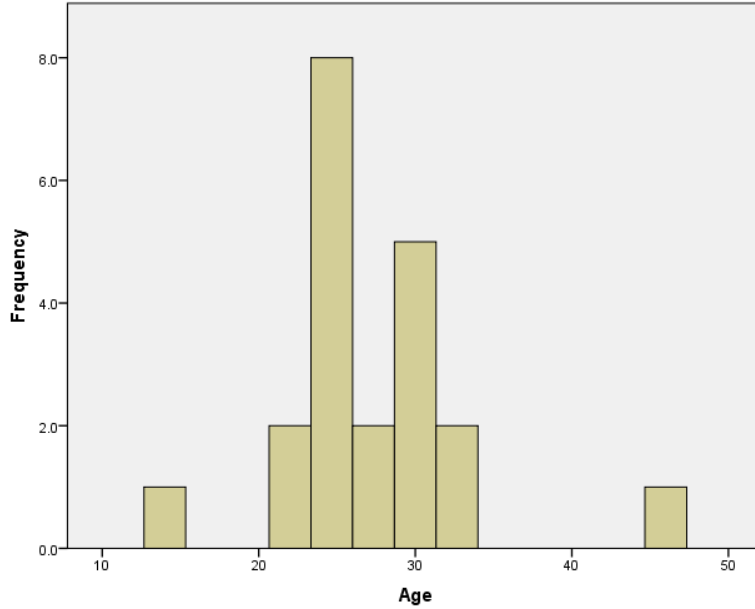


Fig 1. Participants' age distribution

Table 1. Participants' gender distribution

	Frequency	Percent
Male	9	42.9
Female	12	57.1
Total	21	100.0

*Experimental Conditions*

We created two Tumblr blogs with identical content. One Tumblr was paginated with 10 posts displayed on each page and the other used infinite scrolling to display all the content on one page. (Paginated Tumblr: <http://hcde516.tumblr.com/>, Infinitely Scrolling Tumblr: <http://hcde516is.tumblr.com/>) The page layouts were otherwise identical, and captioned images were sequentially presented in the same order on both Tumblrs. The content of the blogs was 110 images of animal memes. We selected this content because it is content that is commonly posted on Tumblr, and it is relatively popular among men and women.



Fig. 2 Animal meme example from this study's Tumblr blogs

### *Procedures*

After the participants were randomly assigned to the paginated or infinite scrolling Tumblrs, we sent two instructional emails, one to the paging participants and one to the scrolling participants. In the emails we included the link to the specified Tumblr and instructed the participants to browse through all of the content on the Tumblr. We told the participants that they would be asked about their browsing experience after looking over their assigned Tumblr, but we did not call out that we would be asking them to recall what they had seen. We included the link to our online survey and requested that the participants not view the survey until after they finished browsing the Tumblr and not refer back to the Tumblr as they completed the survey.

### *Dependent Variables*

The survey measured our two dependent variables: browsing satisfaction and recall. You can view a copy of the survey questions in the Appendix. The survey included a Likert scale that asked participants to rate their experience browsing the Tumblr blog. These questions were phrased indirectly to gain a more realistic sense of what the participants actually thought. Therefore, we did not ask the participants to directly rate their satisfaction with the browsing experience, but instead asked them about their feelings during this experience. We based our questions on Zhang and Zhang's (2013) 23 questions for measuring usage gratification, which we narrowed down to 10 survey items about involvement, spontaneity, and intrinsic enjoyment. We reversed the direction of half of the questions to cancel out the effect of participants automatically marking the same response for all questions.

For the recall part of the survey, we asked the participants to identify which images they remembered seeing on the Tumblr. We displayed 10 images that were from the Tumblr and 10 images that contained animal subjects similar to the images from the Tumblr but that the participants had not seen. Participants selected whether they believed they had seen or had not seen each image on the Tumblr, which allowed us to calculate an image recall score of how many images the participants correctly identified out of 20.

### *Data Analysis*

We chose to analyze our browsing satisfaction data using the Mann-Whitney U Test in accordance with how Eyuboglu and Orhan (2009) classified their user satisfaction survey data as ordinal. We performed this analysis based on the mean of all of each participant's Likert score responses, while reverse coding responses for negatively phrased items (e.g. changing a score of 1 to a 7 for "I feel frustrated when I browse this Tumblr"). We also used a Mann-Whitney U test to analyze the relationship between experimental condition and the total score of images recalled from the Tumblr.

## **Results**

### *Descriptive Statistics*

We used the 21 participants' survey data as the basis for the recall and browsing satisfaction results. Descriptive statistics are detailed in Tables 2 and 3. The recall score was based on the number of image recall questions the participants answered correctly out of 20 questions. For image recall, participants in the paging conditioned had a mean score of 15.67, median score of 17, and standard

deviation (SD) of 3.67. Scores ranged from 11–20. Participants in the scrolling condition had a mean score of a 16.83, median of 17, and SD of 1.7, with values ranging from 13–19. The browsing satisfaction score was the average of each participant’s responses to the Likert questions. For browsing satisfaction, participants in the paging condition had a mean score of 4.23, median of 4.3, and SD of 1.26. The range of values was 2.5–6. Participants in the paging condition had a mean of 4.43, median of 4.25, and SD of 1.09. The range of scores was 2.4–6.2.

Table 2. Image recall descriptive statistics

Condition	N	Mean	Median	Range	Std. Deviation	Std. Error Mean
Paging	9	15.67	17	11-20	3.67	1.23
Scrolling	11	16.83	17	13-19	1.70	.49

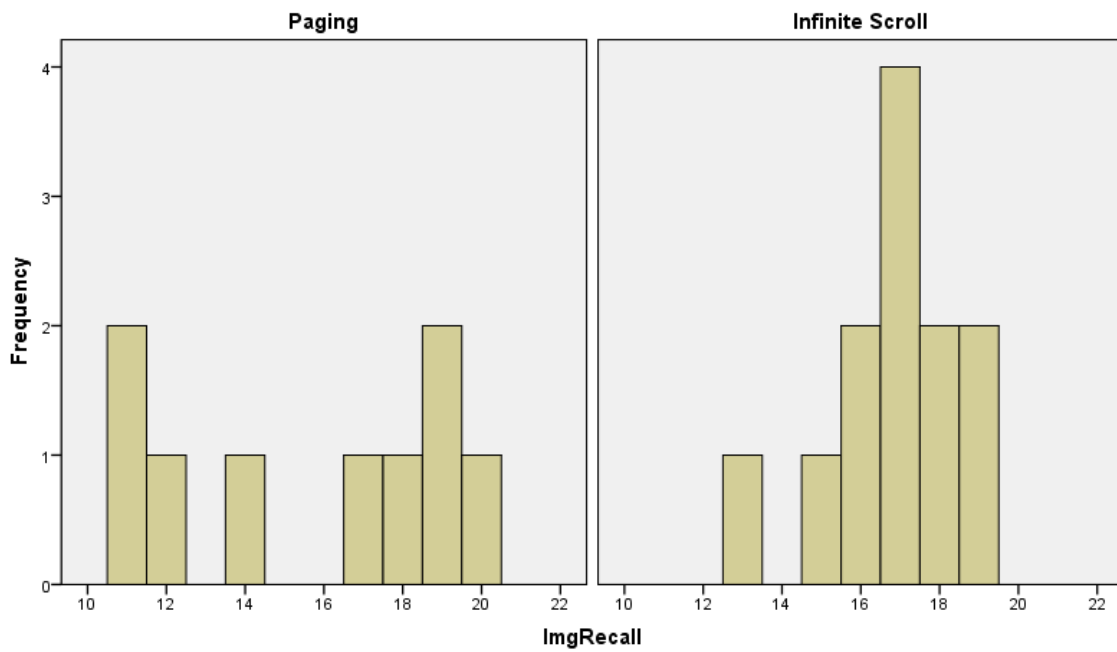


Fig 3. Histograms of image recall scores for pagination and infinite scrolling

Table 3. Browsing satisfaction descriptive statistics

Condition	N	Mean	Median	Range	Std. Deviation	Std. Error Mean
Paging	9	4.23	4.3	2.5–6	1.27	.42
Scrolling	11	4.43	4.25	2.4–6.2	1.09	.31

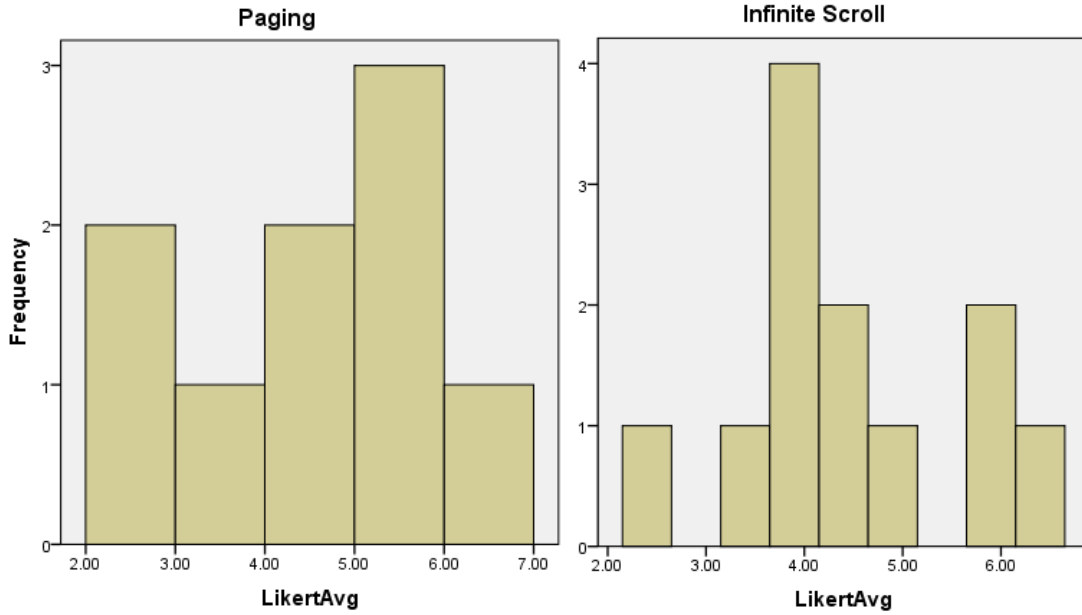


Fig. 4: Histogram of satisfaction scores for pagination and infinite Scrolling

*Image Recall*

We initially performed an independent samples t-test to compare the means of the conditions. However with Levene’s Test for Equality of Variances, we found that the variance in image recall scores between participants in the paginated and infinite scrolling conditions was not equivalent at a statistically significant level ( $F(19)=15.514, p < .001$ ). This difference in variance violates one of the assumptions for the independent samples t-test, that population variances are equivalent, so we performed the Mann Whitney U test instead.

Table 4. Image recall t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	15.514	.001	-.976	19	.341	-1.167	1.196
Equal variances not assumed			-.884	10.567	.396	-1.167	1.319

We hypothesized that participants in the paging condition would have an easier time remembering content versus participants in the scrolling condition, but the participants in the scrolling condition ( $M=16.83 \pm 1.70$ ) actually had a higher mean recall score than participants in the paging condition ( $M=15.67 \pm 3.67$ ) for this study. In addition, there was not a statistically significant difference in the number of images correctly recalled between participants in each condition ( $U=50, z=-.288, p=.774$ ), so we cannot reject the null hypothesis.



Table 5. Image recall ranks

Treatment	N	Mean Rank	Sum of Ranks
0 Paging	9	10.56	95.00
1 Infinite Scroll	12	11.33	136.00
Total	21		

Table 6. Image recall Mann-Whitney U Test

Mann-Whitney U	50.000
Z	-.288
Asymp. Sig. (2-tailed)	.774

### Browsing Satisfaction

We hypothesized that participants in the infinitely scrolling condition would be more satisfied with the experience of browsing the Tumblr versus participants in the paginated condition. Although the mean Likert score for participants in the scrolling condition ( $M=4.43 \pm 1.09$ ) was higher than the mean Likert score for participants in the paginated condition ( $M=4.23 \pm 1.27$ ), there was not a statistically significant difference between the satisfaction of participants ( $U=51.5$ ,  $Z=-.178$ ,  $p=.859$ ); therefore, we cannot reject the null hypothesis.

Table 7. Browsing satisfaction ranks

Treatment	N	Mean Rank	Sum of Ranks
0 Paging	9	10.72	96.50
1 Infinite Scroll	12	11.21	134.50
Total	21		

Table 8. Browsing satisfaction Mann-Whitney U Test

Mann-Whitney U	51.500
Z	-.178
Asymp. Sig. (2-tailed)	.859

### Discussion

We hypothesized that infinite scroll would positively impact browsing satisfaction and inversely affect image recall on Tumblr blogs. However, the results from our study do not allow us to reject the null hypothesis for either variable, because we were unable to find a statistically significant difference between the effect of infinite scroll and pagination on participant image recall or browsing satisfaction. It is possible that we made a Type II error in falsely failing to reject the null hypothesis, but we are unable to utilize Frick's (1995) good effort criterion regarding the null hypothesis because of our small sample size.

Table 9. Summarized hypotheses and our findings

Hypothesis	Results	Conclusion
H1: Participants exposed to the infinite scroll condition will have lower image recall scores	Infinite scroll: $M=16.83 \pm 1.70$ Paging: $M=15.67 \pm 3.67$ $U=50, z=-.288, p=.774$	Cannot reject null hypothesis
H2: Participants exposed to the infinite scroll condition will enjoy the browsing experience more	Infinite scroll: $M=4.43 \pm 1.09$ Paging: $M=4.23 \pm 1.27$ $U=51.5, Z=-.178, p=.859$	Cannot reject null hypothesis

*Interpretation*

The results of this study are inconclusive. We did not find a significant difference between the paginated and scrolling conditions for either dependent variable. The  $p$  values for both browsing satisfaction and recall were very high ( $p=.859$  and  $p=.774$  respectively); however, we can make no claims about the plausibility of the null hypothesis because of the low statistical power of our study. The statistical power for recall was .14 ( $d=.41; n=9, 12; p=.05$ ), which is far below the recommended level of .80. This low power indicates that the lack of a statistically significant difference between samples may have been due to the low number of participants rather than no difference between the two conditions (Evans, Wei, & Spyridakis, 2004). To gain statistical power of .80 with an effect size of .41 and a  $p$  value of .05, we would have needed 94 participants in each group. Our low number of participants was the result of a short deployment period for this study, so we recommend that this study be replicated with a larger sample.

Although we did not find conclusive results about the difference between paginated and infinite scrolling websites in regard to browsing satisfaction and recall for leisure content, it is interesting that our lack of a statistically significant difference aligns with several other studies' results. Eyuboglu and Orhan (2009), Peytchev et al. (2006), and Baker (2003) all found no statistically significant difference between paging and scrolling websites for measures like satisfaction and comprehension. If future studies are able to obtain a high level of statistical power and still do not find a statistically significant difference between infinite scrolling websites and paging websites, then we can conclude that infinite scrolling, like scrolling, may not impact the user's experience in this way and instead may be a stylistic choice on the part of the designer.

*Limitations*

Our data is potentially subject to a variety of participant and experience biases. Due to the limited time we had to conduct this study, we used convenience sampling, so we may have solicited a greater proportion of non-representative Tumblr browsers who were personally interested in animal memes (just like the experimenters). There is a potential ceiling effect on the image recall quiz; scores ranged between 11–20 out of 20, though this may be due to participants in both condition correctly identifying most of the false positive images that they did not see on the Tumblr. Given the normal distribution and variance in browsing satisfaction scores for both conditions, we saw neither floor nor

ceiling effects, which suggests that Hawthorne effects were not in play there. However, we wonder if there may have been a tendency to pick the middle value on the Likert-scale, as both mean scores were near 4 on a scale of 1 to 7 (4.23 for paging and 4.43 for scrolling).

Though we initially considered measuring how much time participants spent browsing all entries of their assigned Tumblr blog, we realized that time on task did not address our research question. The focus of our study was on assessing how well participants remembered what they browsed, as well as on their browsing satisfaction when viewing paginated and infinite scrolling blogs. We did not focus on task performance measures because much of the existing literature in this area has already covered different measures of task performance as a dependent variable. Also, given the limited timeframe for executing this study, we did not have enough time to develop a way to remotely measure how long each participant browsed the assigned Tumblr.

We chose to perform our study remotely, trusting that our participants would not look at the Tumblr when filling out the image recall survey. Our participants may have spent extra time viewing content and may have reported a higher browsing satisfaction rating in order to give us the results they thought we expected. To counteract these effects, we chose deliberately open-ended wording about wanting to assess user experience and avoided mentioning that we were interested in how well they remembered the images they had seen until the final stage of the survey. As we were not present when they filled out the survey, we cannot guarantee that participants solely relied on their memory when filling out the image recall and browsing satisfaction measures.

As we are specifically interested in users' casual Internet browsing behavior, we prioritized having our participants browse in places where they were already accustomed to engaging in such behavior. While the external validity of our findings is improved as our participants performed the study in a familiar and more natural setting, we have reduced internal validity as there may have been other environmental factors that influenced participants' performance, such as noise and interruptions from other people.

The image subject matter featured on our blogs purposely mimics popular content available on many news and entertainment sites employing infinite scrolling and pagination. Animal memes are a popular topic garnering web traffic and social media re-posts. Also these images tend to attract similar interest from men and women and are relatively popular across age groups. Humorous images with ridiculous captions, however, may be more memorable compared to other images frequently posted on social networks implementing infinite scrolling, such as "selfies," celebrity, and product photos. Captioned images may be easier to recall because there is both a visual and textual cue associated with the content. Our participants may also be more interested in animal memes compared to the average social network user; we did not perform a pre-screening measure assessing familiarity with animal memes, so we could not account for how interest in the subject matter affected participants' image recall and browsing satisfaction responses.

### *Recommendations*

Our results might not have implications for web design since we were unable to reject the null hypothesis, but there is still room for further research on infinite scrolling and the impact it has on

user behavior and browsing experience. Little is known about user perceptions of non-text content, paginated or scrolling. The majority of research referenced here used text-heavy content. Future studies could focus on images, video, and other forms of casual content. Also, while previous studies in addition to our own have not found major differences between paging and scrolling effects on satisfaction or task completion, the Etsy case study (Nguyen, 2013) indicates that scrolling navigation can impact key performance indicators. It would be worthwhile to investigate the effect of infinite scroll in other web browsing settings, such as e-commerce.

We also saw a gap in research on the effect of scrolling versus paging on long-term memory. Our study could be duplicated with the added measurement of asking participants to recall images for a prolonged period of time after viewing the Tumblr. Long-term memory impact could be a relevant dependent variable for companies interested in branding and marketing since more brands engage with customers through social channels like Tumblr.

### **Conclusion**

While we were unable to reject or accept the null hypothesis based on our results, we believe that we developed a sound method for this experiment that is worth replicating with more participants in order to ascertain conclusive results. The time scale for this experiment simply prevented us from being able to recruit the number of participants necessary to achieve reasonable statistical power; however, this problem is still an important one to consider. Determining the effect of the amount of content displayed per page on browsing satisfaction and content recall would help web developers make better informed choices about how to display their content. This study can help designers and developers displaying non-textual content critically evaluate their assumptions about how best practices apply to different types of sites and audiences. Conclusive results on the effect of paginated versus infinitely scrolling content could have helped companies like Etsy save time and money when considering how to redesign their websites. Our study provides a framework for future researchers to evaluate page layout's effects on different types of web content.

### **References**

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## Appendix

### Appendix A. Likert scale questions from post-browsing survey

To what degree do you agree with the following statements about your feelings when you browse Tumblr? 1 = Extremely disagree, 7 = Extremely agree	
Category	Likert scale statement
Involvement	1. I could get so involved in this Tumblr that I would forget everything else. 2. Browsing this Tumblr is boring. 3. Browsing this Tumblr helps me forget my problems. 4. I keep worrying about other things when I browse this Tumblr. 5. Browsing this Tumblr totally absorbs me. 6. I just can't get into browsing this Tumblr.
Intrinsic Enjoyment	7. I feel pure enjoyment when I browse this Tumblr. 8. I feel frustrated when I browse this Tumblr.
Spontaneity	9. Browsing Tumblr is a "spur of the moment" thing. 10. I plan time in my schedule to browse Tumblr.

Appendix B. Recall question images from post-browsing survey



**Schrödinger**



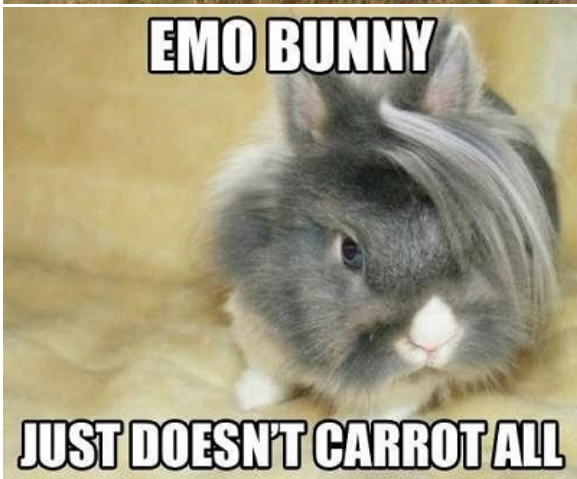
**You Bastard!**

**Day 37:**



**They still do not suspect  
I am a mere cat.**

**EMO BUNNY**



**JUST DOESN'T CARROT ALL**

**THEY SEE ME ROLLIN'**



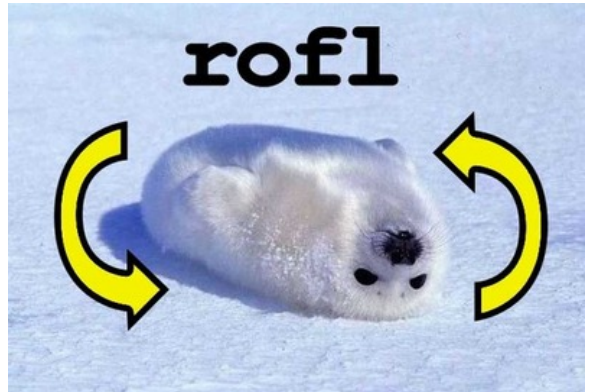
**THEY HATIN.**

POSTED BY: IT  
OMG CUTE THINGS

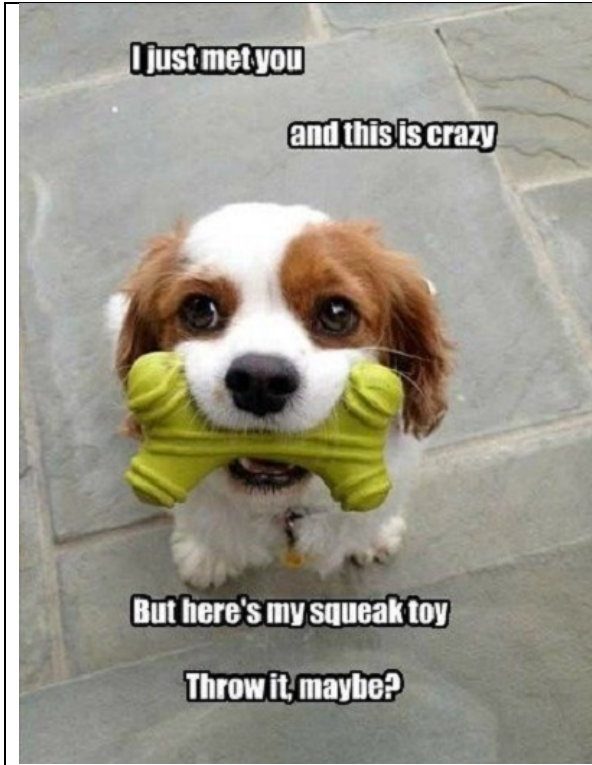
**CARRY ME TO MY  
FOOD**



**SLAVE** 🍏







**I just met you**

**and this is crazy**

**But here's my squeak toy**

**Throw it, maybe?**



**I HAS A FLAVOR**



**Oooooooooo girl!**

**I got my nails did!**