The Use of Eye-Tracking to Evaluate the Effects of Format, Search Type, and Search Engine on the User's Processing of a Search Results Page[1]

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Summary

Seven users did four tasks[2] on both Worldcat.org ("WorldCat") and Books. Google.com ("GoogleBooks"). The tasks represented a combination of Search Type (Known-item or Discovery) and Format (Article or Book).
For each task, users engaged in a Think Aloud protocol while conducting the task, and had their eye-fixations recorded. At the end of all tasks, the users were also interviewed.

Results indicated that the Description accompanying the title of an entry in a results list (i.e., the text below the title that often contains the author, publication date, or a brief description of the entry's content: See the blue area in Appendix C) was very important to both Worldcat.org and GoogleBook users when the format they were looking for was a Book.

However, Title was of greater importance to GoogleBook users when the search format was Article.

It was also found that Facets are of a relatively low importance to both WorldCat and GoogleBook users, but were more often viewed by WorldCat users than GoogleBook users.

Users also preferred GoogleBooks by a 5 to 2 margin, citing the lack of a summary on the Worldcat results page as the primary reason. Users did prefer the presentation and depth of the Facets in Worldcat.org, and indicated that service had a cleaner visual design.

A theory based on Attentional slicing and a new eye-tracking metric are also presented.

Purpose

The purpose of the study is to see how eye fixations of the first screen of a results page are affected by the format a user is asked to consider when doing a task that involves searching for either a specific item or an item related to a specific topic.

Method

Users. Eleven users were recruited via a Craig's list advertisement and announcements posted in locations at the Ohio State University and Otterbein college.

All users were either undergraduate upperclassmen or graduate students who had engaged in online research within the past six months.

Of the eleven users recruited and scheduled, seven participated, with four 'No Shows'.
Users were also compensated with either $50.00 in cash (6 users) or with an Amazon.com gift certificate in the same amount (1 user). Since users were also required to drive to the OCLC Usability lab, they were compensated for their mileage as well.

Profile data for each user is available in Appendix A.

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[1] **Much** thanks to Christie Heitkamp for reviewing this report and her invaluable suggestions for its improvement.
[2] Users also did an additional two tasks related to Fulfillment (Online full text or Purchase). Those results will be discussed in a later report.

Materials. Users were asked to do four tasks that represented combinations of Search Type (Known-item or Discovery) and Format (Article/Paper or Book). The text of each task is in Appendix B.

In addition, users were asked a set of post-evaluation interview questions.

Websites to use were selected on the basis of their range of primary data sources[3] and their scope, as well as the ability to limit format.

Google Books gives researchers the widest range of data sources to search, providing the capability to search sources such as private archives in addition to a number of online library catalogs. Google Books also provides a worldwide data scope, as it includes data from a number of sources across the globe. It also provides users the ability to limit their search to books or articles (a feature not available in Google Scholar).

WorldCat. org provides users a narrower primary data source, with it being primarily from library catalogs. However, as with GoogleBooks, the data scope is worldwide and a user can limit a search by format.

Equipment. Users' eye fixations were tracked using a Tobii T60 Eye tracker. The Tobii eye tracker does not require the user to wear any special head or eye equipment. Instead, user's eye movements were tracked via infrared sensors located in the bottom of the Tobii PC monitor. These sensors 'bounced' infrared signals from the user's pupils back to a set of sensors also located on the Tobii monitor. These signals were then analyzed by Tobii software to determine both the visible screen coordinates of the eye fixation (i.e., the part 'Above the fold'), and the coordinates relative to the entire web page, whether visible or not at the time the fixation was recorded.

Eye fixations were sampled at a rate of 60 per second (about once every 16 milliseconds).

Visual stimuli included not only screens from the target websites (Books.google.com and Worldcat.org), but also panels displaying the text of tasks. These Task screens were not part of this analysis.

Procedure. All users participated at the OCLC Usability lab ("ULab") in Dublin, Ohio.
Upon arrival at the ULab, all users signed a release form, granting OCLC permission to record their actions and comments while completing the tasks. Users were also told they would be doing a series of tasks with one search service and then the same tasks with a different search service.

Users were also given a disclaimer that it was the websites that were being evaluated, not their performance doing the tasks on those websites, and that they could stop the evaluation at any time and still receive their compensation (no user took advantage of this clause fortunately).

Users were then asked for their academic level, levels of experience using GoogleBooks, GoogleScholar, Google, and Worldcat.org, and were informed that for each task, they were to:

(1) Read the task aloud when it appeared on the screen, pressing the ESC key when they were ready to begin the task;

(2) Do the task with that service, engaging in a *think aloud* while they did it. Think aloud (Ericsson & Simon, 1984) was described as "Just what it sounds like – please describe why you are clicking a particular link or filling in a particular box. Also, things you like, things you don't like, and things you find confusing. That is, a running dialog while you do the tasks."

(3) To say aloud when they believe they have completed the task and to then wait for the moderator to tell them to go to the next task.

[3] Theoretically, any data source can be accessed via a link in a metadata record. Hence, the use of the term '*Primary*' in categorizing the data source.

Users were also informed that after all the tasks were completed with both services, they would be interviewed by the moderator.

After acknowledging they understood these instructions, users were asked to situate themselves so that they were "Comfortable and in the position you would be when working with the pc. "

Once situated, they were told to "Follow the red circle on the next screen, moving your eyes but not your head." The Tobii calibration process then began, with a red circle moving to various locations on the screen.

At the end of the calibration, the Tobii eye-tracker displayed whether the calibration was sufficient, or needed to be repeated. Only two users required a repeat of the calibration process. After the calibration was completed, users viewed the first task and the actual evaluation began.

Order of presentation of the GoogleBooks and WorldCat.org services was counterbalanced across the seven users, with four users receiving the GoogleBooks screens first, and three receiving the WorldCat.org screens first.

Results

A. Eye-Tracking Data

Eye-tracking data was collected from all users. Four *Areas of interest* (AOI's) were then designated for the initial Results screen for each user. These AOI's were: Cover Art, Title, and Description for item 1 in the Results list, and the Facets section in the left column on each Results display. See Appendix C.

Item 1 was selected based on the rationale that (1) A user assumes the first item in a Results list is the most relevant (Nielsen, 2005) and will therefore be most diagnostic of where a user initially looks when presented with a results page, and (2) Analyses of all items on a results page other than Item 1 would yield little additional information in comparison to the amount of time and effort needed to do such additional analyses.

The Description AOI included only the descriptive text for the item (the blue area in Appendix C). Since the concern was how a user initially analyzed the information available from a results page when selecting known or unknown items, links in the description not related to this goal were excluded from this AOI. This included the fulfillment links in Google Books and the *Edition and Format* link in Worldcat.org.

Users for which there was no data at all for a particular metric ("drop-outs") were excluded from the analysis of that metric. These drop-outs can be due to head shifts, changes in the rate of data collection by the Tobii software, or other factors unrelated to the assigned task for that screen.

Due to the number of drop-outs across users, the median for each user for each AOI was used as base data. Because of the low number of users, the median of these medians was then used for the data analyses reported below. When the sample size is small and with wide variation, the median is a more accurate predictor of the 'true' value of the data collected than the arithmetic mean (Dean & Dixon, 1951).

The metrics collected included: (1) Percentage of users fixating on an AOI, (2) Median first fixation on AOI, (3) Median fixation count per AOI, (4) Median fixation duration per AOI, and (5) Median visit count per AOI. Each of these metrics is explained in greater detail below.

In each figure, the number of users for which eye-tracking data was available for each of the four combinations of *Search Engine/Search Type* is in parentheses next to the corresponding label in the figure's legend. Any descriptions or percentages of users discussed in this paper are based on this number, and not the overall number of users (7).

In addition, the number of users used to calculate each measure for each AOI for a metric is listed in parentheses in the bar corresponding to that AOI. Where indicated, this number reflects only those users who had at least one fixation in the corresponding AOI for that metric.

Percentage of users fixating on an AOI. This metric assumes that the more users who fixated on an AOI, the more noticeable or important was that AOI overall (Fitts, 1950; Poole et. al., 2004). Any user was counted who had at least one fixation in a given AOI.

Books (Figure 1). For Discovery searches in Worldcat.org, all users had at least one fixation on the Description area, followed by 83% of those users on Title, for the Book format.

For Known-item (KI) searches, both Title and Description had 83% of users fixating on them.

Interestingly, the Facet section for a Known-item search received as much attention as did the Description and Title areas, and Cover Art was not far behind at 67%. This data might indicate that users found all these sections interesting, contradicting the data presented previously that indicated facets were of relatively low importance. However, since **all** the AOI sections received almost equal percentages of user fixations, it may be more likely that such a wide but equal dispersal of fixations meant users could not find what they were looking for (Goldberg & Kotval, 1999).

In GoogleBooks, similar data was obtained for the Description AOI for a KI search. However, only 33% of users viewed the Title AOI for a KI search, while 83% viewed the Cover Art.

Interestingly, no users viewed the Facets in GoogleBooks for a Discovery search, while 50% of users did for a KI search.

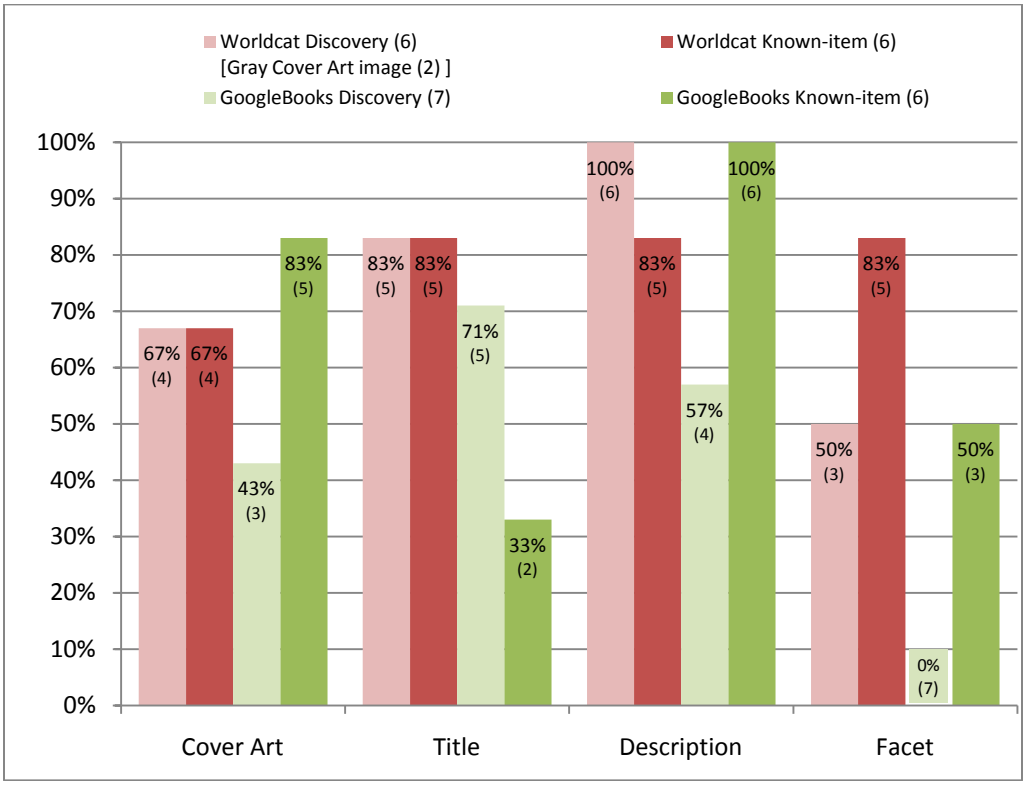


Figure 1. Users who had at least one fixation on an AOI in the Book format

Articles (Figure 2). When asked to find an article, 100% of Worldcat users viewed the Description of the first item, regardless of whether the search was Discovery or KI. However, only 67% in Discovery, and 57% in KI, viewed the Title AOI when the target Format was article.

However, for GoogleBooks, Description was viewed by only 50% of users in a KI search, and only 40% of those in a Discovery search. Title however, was much higher, at 80% for a Discovery search, and 83% for a KI search.

Thus, for both KI and Discovery searches for an Article, Description was again the most "attended to" area for Worldcat.org user, but for GoogleBook users, it was the Title AOI that received the most attention (see Figures 3 and 4).

It is interesting to note that the Description field in Worldcat was fixated on at least once by all but one user, regardless of Search Type or Format. This may be because this field contains an icon representative of the Format type, or had more white space around it. Both of these attributes distinguish it from the GoogleBooks Description area that consisted of pure text with less surrounding white space.

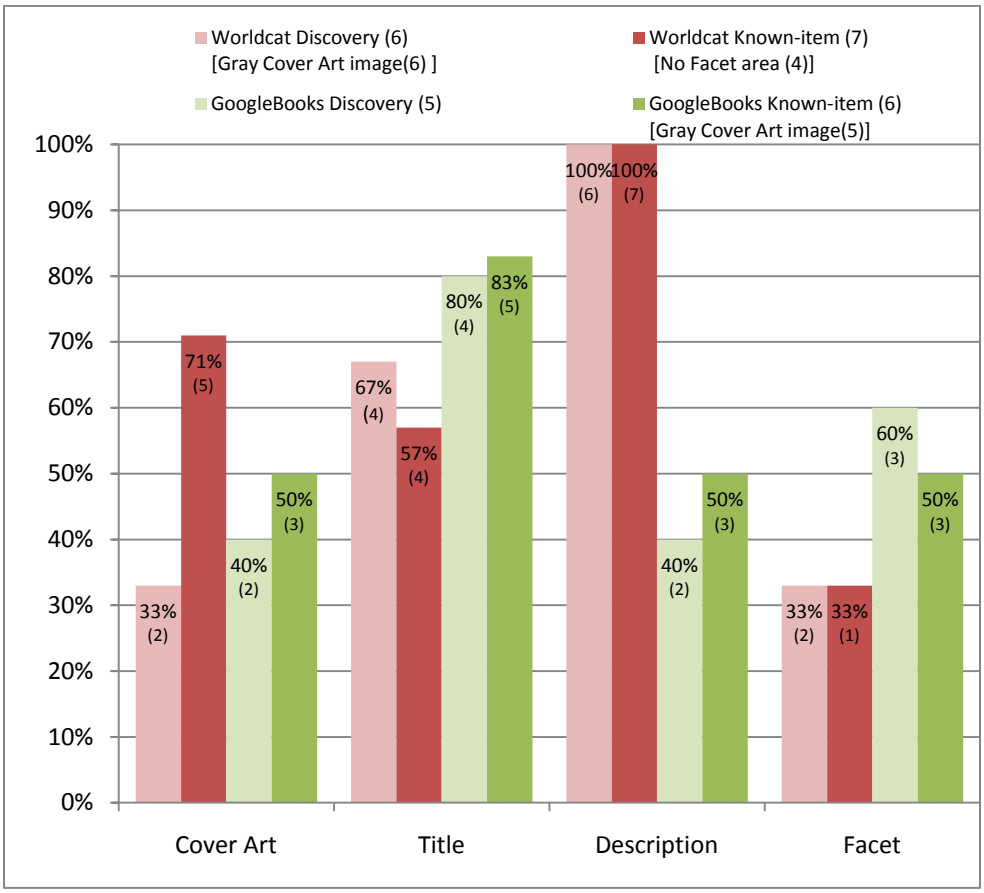


Figure 2. Users who had at least one fixation on an AOI in the Article format

First fixation on AOI. The fewer fixations it takes a user to find a target AOI, the more likely it is to get a user's attention (Byrne et al., 1999). A value of one (1) for an AOI indicates that AOI was the first area *anywhere* on the screen the user fixated on when the screen was displayed.

Books (Figure 3). For all Search Types and Formats, the Facet AOI was the least likely to draw a user's attention. This was true for both Worldcat and GoogleBooks.

For both Discovery and KI searches, the cover art image was viewed on the first or second fixation by users of GoogleBooks (Mdn=1.5), while WorldCat users took an extra fixation before fixating on the cover art, generally finding it on the second or third fixation on the page (Mdn=2.5).

Description was 'found' quicker than Title by a slight margin for Worldcat users for both Search types. This was also true for KI searches done with GoogleBooks. However, Description was found after title for a Discovery search in GoogleBooks.

It is worth noting that while all Google Book displays contained a book cover image for item 1, for two of the six Worldcat users who were tracked in Task 1, no cover art was displayed. Instead, these users were presented with a blank, gray rectangle of the same size and in the same location as the item's cover art would be displayed (a "No Cover Art" image but without any text). This image is intended to convey that no cover art was found for that item. It was these two users who did not fixate on the 'cover art', while the remaining four users whose display **did** contain cover art all had at least one fixation on that image.

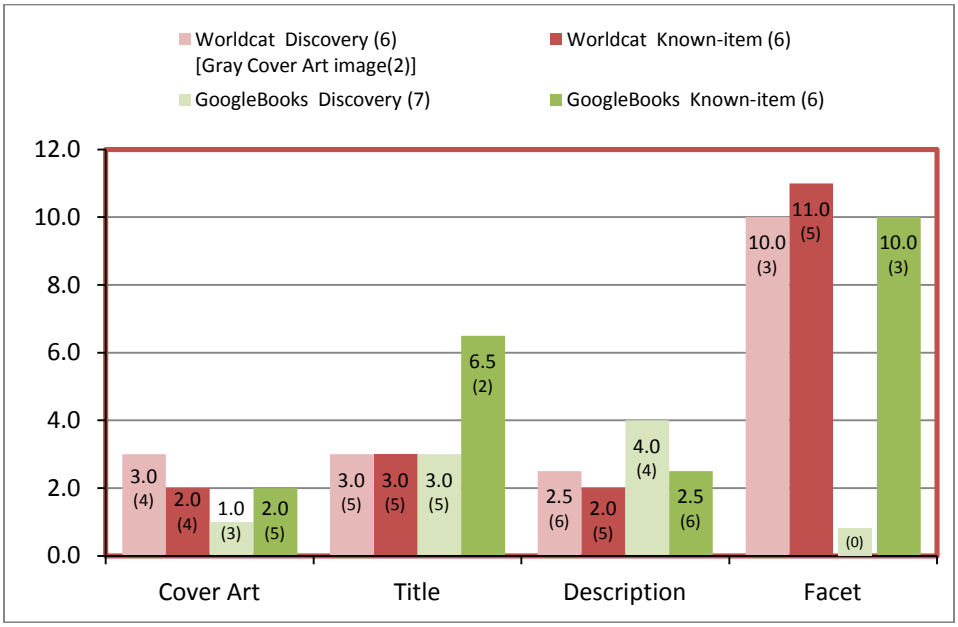


Figure 3. Fixation number of first fixation on an AOI in the Book format

Articles (Figure 4). For articles, users were much quicker to locate the title for a KI search in GoogleBooks than in Worldcat (medians of 1.0 and 4.5, respectively), and for a Discovery search (Medians of 2.0 for GoogleBooks, and 5.0 for Worldcat).

For Worldcat, the AOI most often fixated on first when searching for an article was the Cover art for a KI search, with five of seven users fixating on it first. Conversely, the user's first AOI fixation in GoogleBooks for a KI search was on the title (5 of 6 users).

Overall, users in Worldcat appear to attend to the Cover Art first in a KI search, but to the Description in a Discovery search.

In GoogleBooks however, while users tend to look at the Title, first for a KI Article search, they look at the Description before the Title for a Discovery search, regardless of the format.

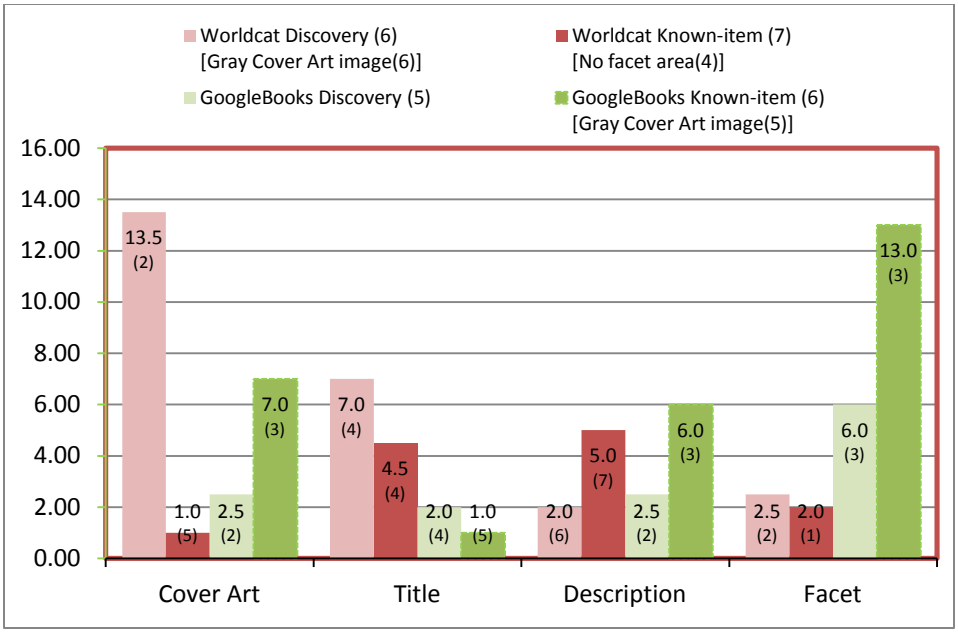


Figure 4. Fixation number of first fixation on an AOI in the Article format

Fixation Count per AOI. The number of fixations on a particular AOI should be indicative of the importance or "noticeability" of that AOI to a user in accomplishing the task (Fitts et. al., 1950; Poole et. al., 2004). However, it is also possible that this metric reflects the number of words or 'chunk' needing processing (Polle & Ball, 2005). Hence, high fixation counts for Facet and Description AOI's may be due to their length more than how attention-grabbing they are to the user.

Books (Figure 5). For Worldcat, the Facet area was fixated on most often for a KI search, but as noted, this may be due to its length.

More interestingly, a book's title received more fixations for Worldcat during a KI search type then did Description, even though Description would be expected to contain more words to process. This length effect may in fact be what accounts for the high number of fixations for the Description area in a Worldcat Discovery search.

For GoogleBooks, the Description AOI did receive more fixations than Title, Cover Art, or Facets, for both Discovery and KI searches (though Title did receive almost as many fixations as Description).

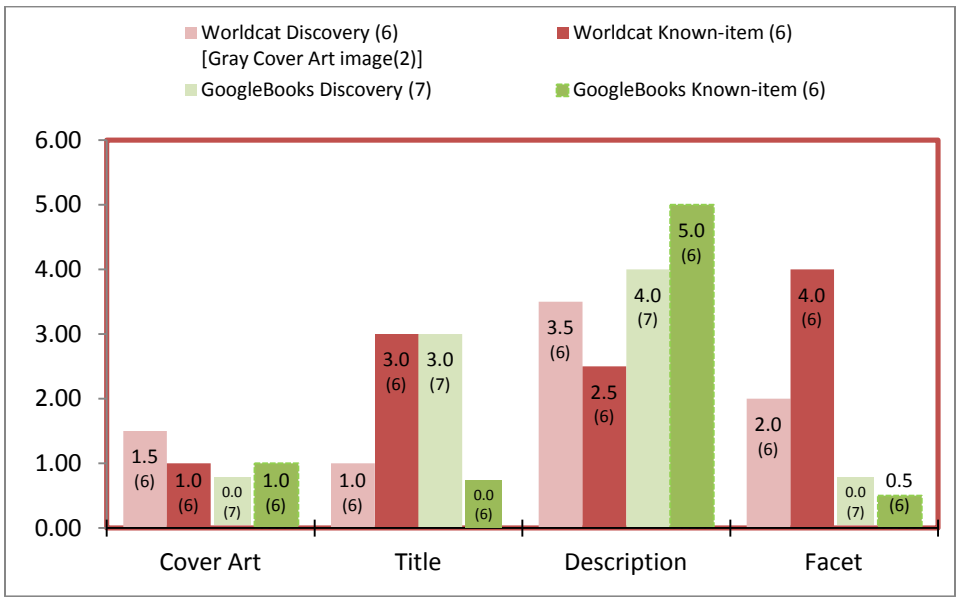


Figure 5. Median number of fixations for each AOI in the Book format

Articles (Figure 6). For articles, the Description AOI for Worldcat for both KI and Discovery searches received the most fixations, which again may be attributed to the length of this AOI compared to that of the other AOI's.

What is more surprising is that most users did not fixate on the Facet area in Worldcat when looking for an article. This may be because Worldcat users could limit their search to Articles on the home page, and so did not need to use the Facets to limit to Articles. A quick scan of the video tapes indicates that indeed, most users would limit to Articles from the home page in Worldcat.org before viewing the Results page.

For GoogleBooks, the Title of the article in a KI search received four times more fixations than Facets, Cover Art, or Description, for the same search type. But for a Discovery search, it was again the Facet AOI that received the most attention.

These results again indicate that for both a Discovery and KI search, the Description appears to be the key component for a Worldcat.org user, especially for a Discovery search for an article. But for a user of GoogleBooks, the Title draws the most attention by far when doing a KI search for an article.

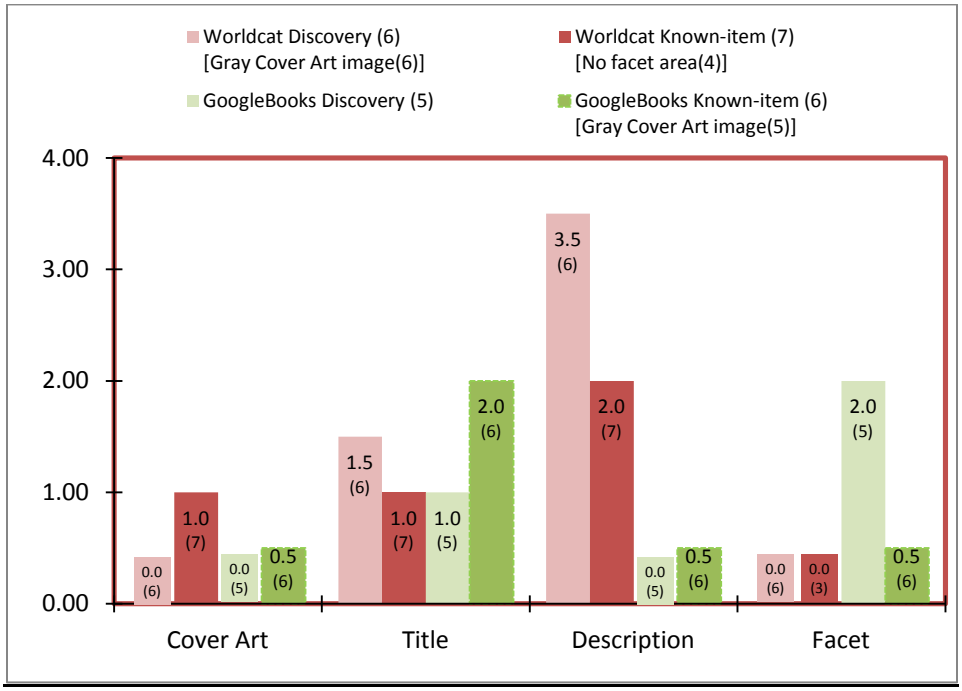


Figure 6. Median number of fixations for each AOI in the Articles format

Fixation Duration. – The median duration per fixation for each AOI. This metric is felt to correlate positively with the user's difficulty understanding that AOI (Goldberg & Kotval, 1998) or in extracting information from that AOI (Just & Carpenter, 1976), though others suggest it may indicate the AOI is "More engaging in some way." (Poole & Ball, 2005).

Given these differences in definition, a reasonable definition is that for this metric, the longer the fixation, the more processing the user devoted to that AOI. The Tobii software does not allow the inclusion of fixations of duration zero (i.e., that is, no fixation), so this metric is limited to only those users who fixated at least once on a particular AOI.

Books (Figure 7). Worldcat users appear to spend the most time processing the Description area, followed by Facets, Title, and Cover Art for a book search. It is interesting that this ordering was the same for both Discovery and KI search types.

For GoogleBooks, the fixation duration for Title in a KI search needs to be discounted by the number of data points (two, meaning that 4 users did not look at this AOI at all). With that caveat, it appears that for a Discovery search, Title received slightly longer fixations than either Cover Art or the Description.

Over both Search Types and Formats, the shortest fixations were on the Cover Art. Perhaps a picture is worth 1000 words.

Perhaps of most interest is the large difference between the amount of time devoted to the Description for Discovery and KI searching in Worldcat when compared to the same searches done in GoogleBooks. Much more time is spent on the Description in Worldcat than in GoogleBooks, again suggesting the high importance attached to that area by a Worldcat user looking for Books, but a decreased interest by GoogleBook users. Alternatively, the Description area for a Google books' entry may be of equal importance as the same area in a Worldcat. Org results list, but allows the user to extract and process needed information more quickly.

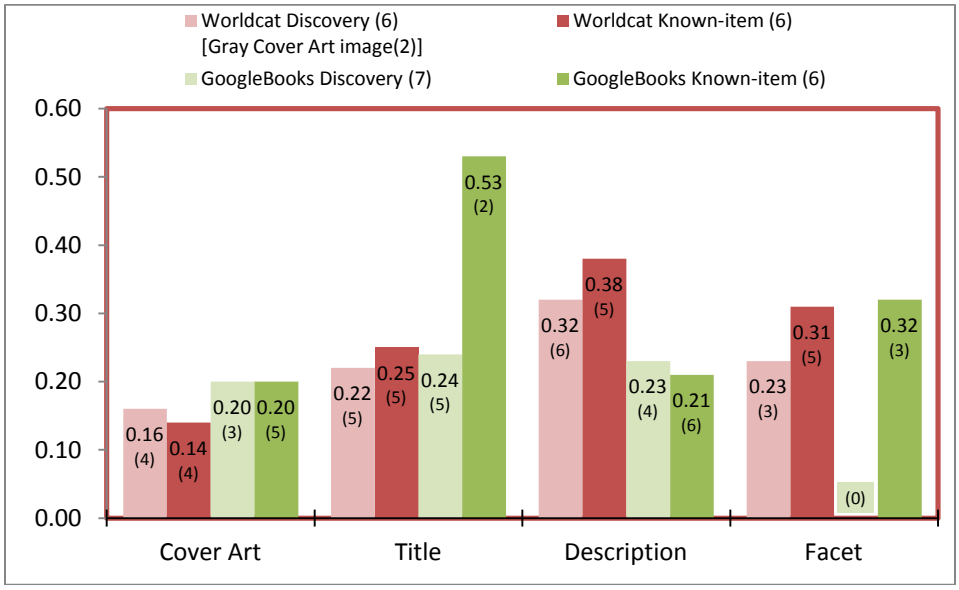


Figure 7. Fixation duration for users who fixated at least once on an AOI in the Book format

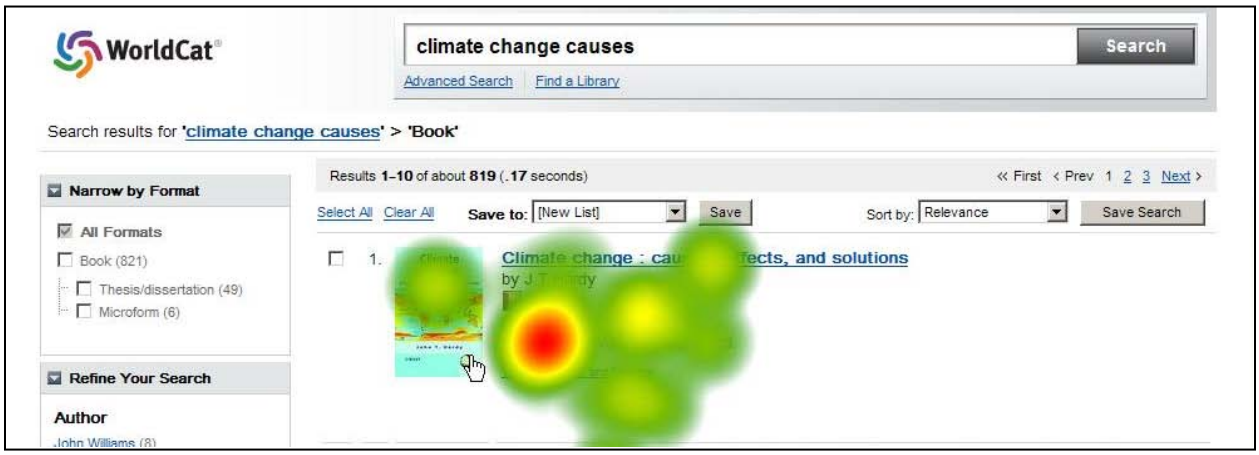


Figure 8. For a Discovery/*Book* search In Worldcat.org, users fixated longest on the Description.

Figure 9. For a Discovery/*Article* search In Worldcat.org, users again fixated longest on the Description.

Articles (Figure 10). Again, the Description area for Worldcat had the longest fixation durations for both a KI search and Discovery search. Interestingly, the actual values are almost identical to those for the Book format. Moreover, Title followed Description for an Articles search just as Title follow Description for a Book search.

While the longest fixation duration is similarly seen for Description for a Discovery search in GoogleBooks, the opposite relationship emerges for GoogleBooks for a KI search: The longest fixation duration is now devoted to Title, with much less devoted to Description. In fact, both Cover Art and Facets received longer fixation durations than did the Description for a KI/Article search.

Taken together with the previous metrics, these data would seem to indicate that a long median fixation time is not so much an indication of processing difficulty as of processing attention.

That is, just as when we are searching for a familiar, lost watch in a field, we fixate longer on shiny objects than 'non-shiny' ones, we do so not because non-shiny objects are somehow easier to process, but because we have set our attentional filter to ignore them entirely.

Similarly, eye fixations that are relatively much shorter for an AOI may not indicate that AOI is somehow easier to perceive and comprehend.

Instead, it may be because that AOI does not have a key attribute of the target information (perhaps its location is wrong), and we have learned to devote almost no attentional processing time to anything that does not have that key attribute.

This process of narrowing our attention to one or two key attributes of what we want to attend to, to the exclusion of other attributes, is known as 'Attentional slicing' (Fraundorf, 1970). Without it in daily life, we would be overwhelmed by the amount of stimuli entering our visual field each second. Its use in processing search results would seem a logical extension[4].

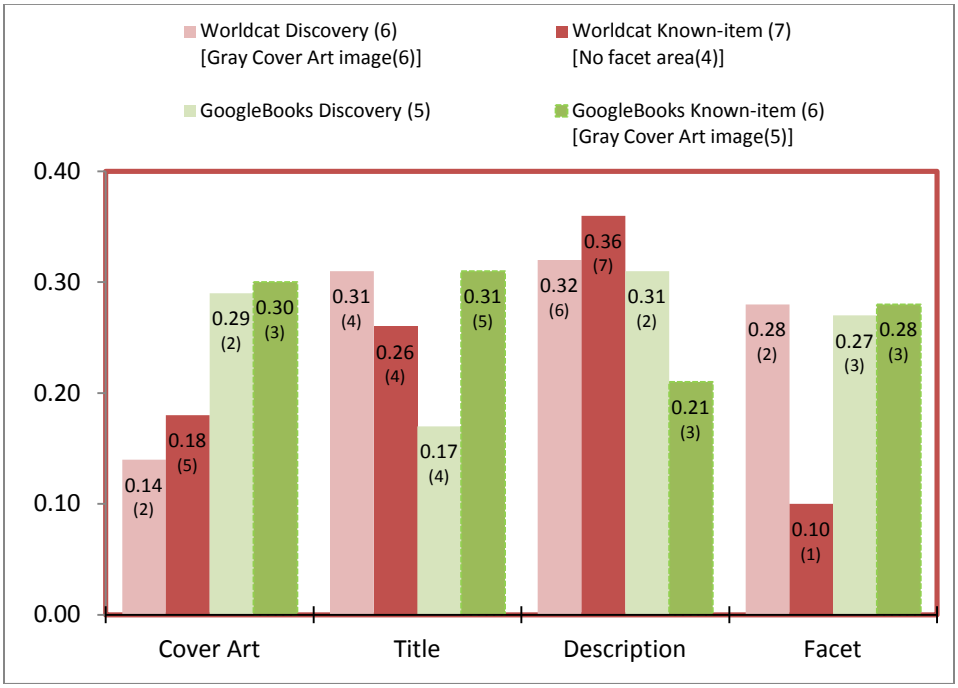


Figure 10. Median fixation duration for users who fixated at least once on an AOI: Articles format.

[4] A similar effect known as 'Banner Blindness', where a user completely ignores large sections of a web display (e.g., ads in the right column of a screen) may also be related to attentional slicing.

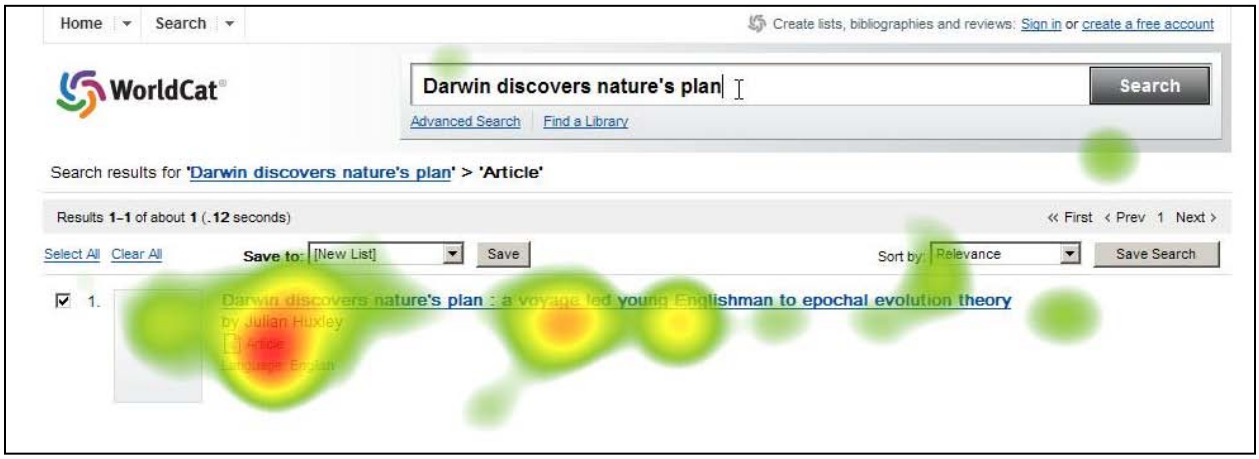


Figure 11. For a KI/Article search In Worldcat.org, users fixated longest on the Description

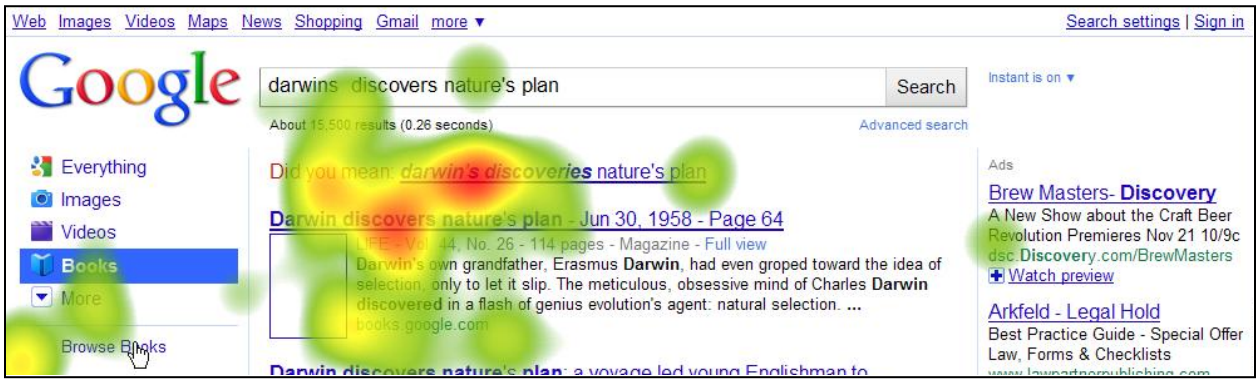


Figure 12. For a KI/Article search In GoogleBooks, users fixated longest on the Title.

Visit Count. Number of visits to an AOI. A *visit* (sometimes called a gaze) begins when a user first fixates on an AOI, and ends when the user fixates on something outside of the AOI. There can be any number of fixations in a visit. When a user fixates on something outside the AOI, and then returns to the AOI, that is counted as the beginning of another visit.

Visit *duration* is the sum of the duration of each fixation within a visit, and is sometimes used as a measure of the distribution of a user's attention among the AOI's (Hauland, 2003).

However, since visit duration is impacted by the number of fixations during a visit, it is confounded with the number of words in a text passage, since the more words in a passage, the more fixations it would take to process it. Thus, a long visit duration for a Description AOI may be due not to increased interest in that description, but simply because it has more words to read than another AOI.

An alternative measure is visit *count*. Visit count is independent of the number of fixations in a visit: A visit with 1 fixation and a visit with 10 fixations both count as one visit.

It is proposed that a high visit count is indicative of increased interest in an AOI. For example, a title with a visit count of 2 means a user gazed at it, left it, and then returned to gaze at it again. Such a return to an AOI would seem to be a good indicator of interest in that AOI.

Those users who did not visit a particular AOI at all (Visit count=0) are included in the data.

Books (Figure 13). Worldcat users doing a Discovery search were almost twice as likely to return to the Description AOI than to the Title or Cover Art AOI's.

Similar behavior occurred for a KI search in Worldcat: Users were most likely to return to the Description than to any of the other AOI's.

In contrast, GoogleBook users doing a KI search were just as likely to return to the Title as they were to the Description AOI. For a Discovery search however, they displayed the same pattern as a Discovery search in Worldcat: They were twice as likely to return to the Description as to the Title. In fact, they were more likely to return to the Cover Art than the Title.

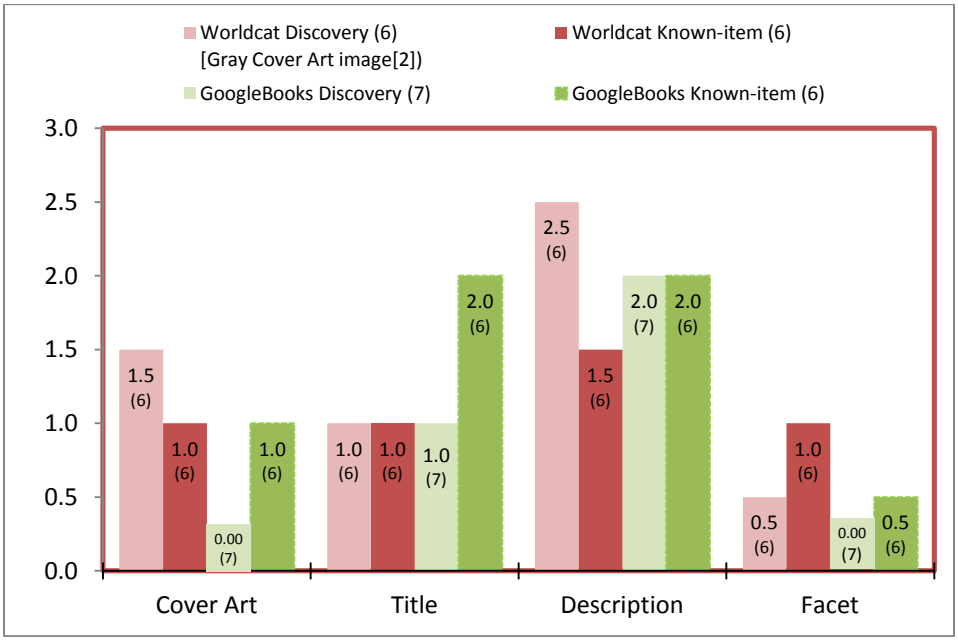


Figure 13. Number of visits (gazes) for each AOI in the Book format

Articles (Figure 14). The pattern seen for Books is seen again for Articles, with the exception of GoogleBooks Discovery search. Description AOI's for WorldCat are twice as likely to be re-fixated as Titles, regardless of the Search type.

For GoogleBooks, the pattern is reversed: Users doing a KI search are much more likely to review the Title than the Description, although much less likely than when they are scanning a Results list for a book.

However, GoogleBook users are more likely to review the Title than the Description for a Discovery search as well, opposite to the findings for a GoogleBook's Discovery search for a book.

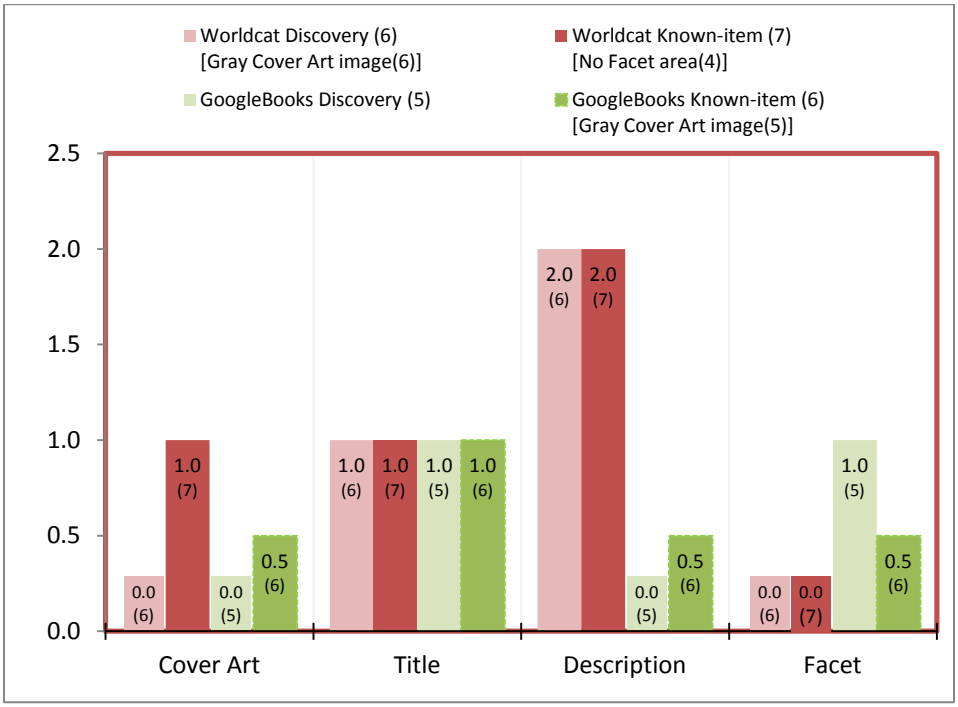


Figure 14. Number of visits (gazes) for each AOI in the Article format

B. Interview Responses

Preference. Users were asked "*Overall, which service, Worldcat.org or GoogleBooks, did you prefer? "* Five of the seven users preferred Google books. Common reasons were:

- *"Could preview book (on results list)" (2A)*
- *"Worldcat does not have summaries on results page" (3A)*
- *"Could get to content right from results list. Did not need to go to library." (4A)*

For the two users who preferred WorldCat, both cited better search limiters (facets) on the results page ("*Facet column is nice.*" 11A), and better organization ("*Seemed more academic, better organized.*" 5A).

Preferred sites for online text. Users were asked "*Which sites do you typically use when looking for online information or full text content on topics of interest?*"

The results for the first choice were mixed: Two users cited Google (3A and 8A), two users cited PubMed (4A and 5A, the pharmacy and veterinary students), one user cited Google Books (10A), one cited Google Scholar (11A), and one user cited the OSU library website (2A).

However, for the second choice, three additional users cited the OSU library website. Hence, four of the seven users mentioned the OSU library website as part of their answer to this question.

Page Likes and Dislikes. Each user was shown a Results page for the search "Theory of Evolution" for both Worldcat.org and GoogleBooks.com. They were then asked *"What things do you like about this page? What things do you not like about this page?"*

For the WorldCat.org Results page, users liked the ability to limit using facets (2A, 3A, 11A), the layout of the page (3A, 5A, 8A) ("*When available*" as one user qualified their answer), and that could easily tell format , title, and author information (4A, 10A).

The most common dislike of the WorldCat.org Results page was not being able to see a brief summary, cited by four users (2A, 3A, 4A, 10A) ("*Even 1 or 2 sentences would help.*" stated user 4A).

For the GoogleBooks results page, users liked the availability of a brief summary (3A, 4A) and the presence of Cover Art (2A, 4A). Two also noted its similarity to Google made it easier to use as well.

The most common dislike (3A, 4A, 5A, 8A) was the presence of ads that "*Take up too much room*" (8A) AND MAKE GoogleBooks "*Like Wikipedia, not trustworthy.*" (5A).

Users also indicated they would like more limiters, indicating there were fewer ways to narrow a search, "*Cruder date narrower*" (3A).

T**ask difficulty due to layout of screen.** Users were asked if the "*Found any tasks difficult to complete because of the user interface of either service*".

Three users said the most difficult task was finding how to purchase articles in worldcat.org (2A, 4A, 8A).:

- "*Have to click on each (entry in Results) to determine if can purchase online.*" (4A)
- "*Hard to find place (area on screen) to purchase*." (2A).

While this purchasing feature is offered by Worldcat.org, it is one that usage data indicates is rarely used and not of high importance to users overall.

Two users indicated the most difficult task was finding edition information in Google Books because "*Had to scan the original text (to find it)*." (3A).

Also cited was the difficulty in using GoogleBooks to find articles, which was easiest to do if the user narrowed by the 'Magazine' facet. Most users seemed unaware of this option, such as user 4A, who concluded the reason the task was so difficult was because in GoogleBooks, "*Sources are older*.". One user even thanked the moderator after the evaluation for pointing out the 'Magazine' option during the post-evaluation interview.

What users would change. The final interview question asked users "*If you could change GoogleBooks/Worldcat.org in any way, what would you do?*"

For Google Books, most often cited was to remove the advertisements (2A, 5A, 11A). Three users also indicated the addition to GoogleBooks of more ways to surface material of interest would be a welcome addition: "*They do not seem as all inclusive as in WorldCat*." (3a).

For WorldCat, the change most requested was the addition of a summary to the Results page (2A, 3A, 4A, 5A):

- *"Results should have short summaries."* (4A)
- *"Add brief synopsis, as have lots of white space."* (5A)

Also cited was the ability to purchase an item from the Results page (2A, 8A):

- "*Great as a library reference, but if actually trying to purchase item, would like it on the Results page*." (8A).

Perhaps user 3A summed it up best when she said:

- *"If Worldcat had a synopsis on the results page and online text access, I would be more likely to use it than GoogleBooks."*

Discussion

Users seem to process the results of a search for Books somewhat differently than they do for Articles, depending on the Search engine and to a lesser extent, on the Search Type.

In general, users attend quicker and more often to the Description when the Search engine is Worldcat.org than when it is GoogleBooks. This is true for both Books and Articles.

However, for GoogleBooks, while Description was attended to more often in a KI/Book search, it was the Title area for both Books and Articles that received more fixations in a Discovery search. The title area also received more fixations in an article search for a Known-item.

Similarly, for Worldcat users, Description was also 'found' slightly quicker than Title for Book searches regardless of Search Type (though Cover Art was found before either Description or Title in a KI search).

For an article search done on GoogleBooks however, it was the Title area that was 'found' sooner than the Description area. This also was true for both Discovery and Known-Item (KI) searches.

These results may be due to several factors. Visually, the Title in Google Books results list entry is a larger font size (16 pixels in Mozilla's default font size) than in Worldcat.org (13 pixels)[5].

The Title also extends over the top of the Cover Art in Google Books, whereas the Title in a Worldcat.org terminates at the right edge of the cover art, making it left-aligned with the Description. The net result is that the Title in Google Books is more spatially distinct than the Title in Worldcat.org from the Description section, which may make it easier to locate.

Perhaps more importantly, the *entire* Description component of a results list entry in Google Books is in a smaller font size than the title (13 pixels). However, in Worldcat.org, the first line of the Description (usually the author's name) is the same font size as the Title (13 pixels) with the remainder of the Worldcat.org description rendered at 11 pixels. This has the effect of making the title visually 'chunk' with the Description more in a Worldcat.org entry then for a GoogleBooks entry. This would make the Title more difficult to discern (and to some extent, the Description *easier* to discern) in a WorldCat entry.

A final possibility is the layout of the information in the Worldcat.org Description section. The information is laid out like a list, with each line containing a separate piece of information about the entry. Conversely, the Description area in a GoogleBooks is a brief description of the entry, i.e., it is laid out as continuous text.

It is well-known that users find Web information laid out in lists quicker than information presented as continuous text because users do not 'read' websites: They scan them (Morkes & Nielsen, 1997). Scanning is a form of attentional slicing, discussed earlier in this paper. Hence, the list layout of WorldCat.org's Description area may have been the key attentional feature used to identify where important information was likely to be located.

Another finding was the use of the Facet area for a Book search. For Worldcat, the Facet area was fixated on by 83% of users sometime during a KI/Book search, and 50% for a Discovery/Book search.

However, for GoogleBooks, no user looked at the Facet AOI for any Discovery/Book search, and only 50% of users fixated on it for KI/Book search.

[5] Font size measurements were determined with the add-on FireBug and as rendered by Mozilla Firefox V. 3.6.13.

But for neither WorldCat nor GoogleBooks was the Facet area a real 'attention- getter' for Books. Even when users did view it, it was on the 10th or 11th fixation.

Fixation length is associated with a greater *difficulty* in understanding an AOI (Just & Carpenter, 1976).

But in the current study, If a user did fixate on an AOI, the longest fixations for a Worldcat user was on Description for both Search Types whether the search was for a book or an article. The longest fixations for a GoogleBooks user was on Title.

These data seem to support a different view of Fixation length: That it is a measure of the amount of processing the user is devoting to that AOI. This may not be because it is difficult to understand, but that the user has 'sliced' their attention to more quickly scan for only a few key features (similar to only looking for the feature 'shiny' when trying to find a lost watch in a field).

When a possible hit is then fixated, more attention is brought to bear to determine if it is what the user was looking for. They consequence is a longer Fixation length.

An often overlooked metric, "Visit count" was also proposed as a better measure of the importance of an AOI then "Visit duration".

A 'Visit' consists of multiple sequential fixations on a single AOI, initiated when a user first fixates on an AOI, and terminated when the user moves her view off of the AOI.

As such, a visit may be subject to confounding with the number of words to read in an AOI. That is, the more words to read, the more fixations are needed and the longer the visit duration, regardless of the importance of the AOI to the user.

However, Visit Count does not depend on the number of fixations in a Visit, only on how often the user has *returned* to an AOI to review it. Whether a visit has 1 fixation or 20 fixations before a user moves her view from an AOI, they both count as one visit. Such a return visit would seem to be a good indicator of interest in that AOI.

The data suggests that this is the case: Visit Count aligned well with the other metrics used in this study.

For example, Visit Count was highest for the Description AOI for both WorldCat and GoogleBooks for the Book format and either Search type.

However, for an Article search, while Visit Count remained high for the Description AOI for Worldcat, it dropped to almost zero for GoogleBooks for the same AOI. It was the title AOI Visit count that was highest in this case for GoogleBooks, very similar to the findings from the other metrics used in this study.

Preference data was also taken, and indicated that users preferred GoogleBooks to Worldcat by a 5 to 2 margin. The most often cited reason was that Worldcat did not have summaries on the results list, while GoogleBooks did.

Users did prefer the Facets in Worldcat to those in GoogleBooks, finding them more complete and easier to use. Users also disliked the ads present on GoogleBooks, seeing them as distracting and lowering the credibility of the service.

In conclusion, the results of this study indicate that eye tracking data can be very useful in understanding how users process the Results of a search when determining what items to select for further analysis.

It may be especially helpful in identifying the areas on the Results page that should be emphasized and made easiest to access and use, and those areas that can be de-emphasized, moved to another page, or removed entirely.

References

Anderson, R., Nyström, M., & Holmqvist, K. (2010). Sampling frequency and eye-tracking measures: how speed affects durations, latencies, and more. *Journal of Eye Movement Research*, 3(3), 6, 1-12.

Byrne, M., Anderson, J., Douglas, S., & Matessa, M. (1999). Eye tracking the visual search of clickdown menus. *Proceedings of CHI'99* (pp. 402-409). NY: ACM Press.

Cornett, C. Eyetracking metrics for usability studies (2010, June 14). *InspireUX*. Retrieved December 6, 2010 from http://www.inspireux.com/?s=metrics

Dean,R. & Dixon, W. (1951, April). Simplified Statistics for Small Numbers of Observations. *Journal of Analytic Chemistry*, Volume 23, No. 4, pp. 636-638.

Ericsson, K. A., & Simon, H. A. (1984). *Protocol analysis: Verbal reports as data*. Cambridge, MA: Bradford Books/MIT Press.

Fraundorf, P. (1970). *A simplex model for layered niche networks*. Retrieved December 16, 2010, from http://arxiv.org/abs/physics/0603068.

Goldberg, J. and Kotval, X. (1999, October). Computer interface evaluation using eye movements: methods and constructs. *International Journal of Industrial Ergonomics*, Volume 24, Issue 6, Pages 631-645.

Hauland, G. (2003). Measuring team situation awareness by means of eye movement data. In *Proceedings of HCI International 2003*: Vol 3 (pp. 230-234). Mahwah, NJ: Lawrence Erlbaum Associates.

Jacob, Robert, & Karn, K. (2003) Eye Tracking in Human-Computer Interaction and Usability Research: Ready to deliver the promises. In Hyona, J.; Radach, R.; Deubel, H.; *European conference on eye movement research; The mind's eye*; Amsterdam; London; North Holland; 2003; p. 573-606.

Josephson, F. (2004). A Summary of Eye-movement Methodologies. *FactOne*. Retrieved December 9, 2010 from http://www.factone.com/article_2.html.

Just, M. A., & Carpenter, P. A. (1976). Eye fixations and cognitive processes. *Cognitive Psychology*, 8, 441-480.

Morkes, J. & Nielsen, J. (1997). Concise, SCANNABLE, and Objective: How to Write for the Web. *AlertBox*. Retrieved February 8, 2011 from http://www.useit.com/alertbox/defaults.html.

Nielsen, J. (2005). The power of defaults. *AlertBox*. Retrieved December 16, 2010 from http://www.useit.com/alertbox/defaults.html.

Poole, A., & Ball, L. (2005). Eye Tracking in Human-Computer Interaction and Usability Research: Current Status and Future Prospects. Chapter in C. Ghaoui (Ed.): *Encyclopedia of Human-Computer Interaction*. Pennsylvania: Idea Group, Inc.

Poole, A., Ball, L. J., & Phillips, P. (2004). In search of salience: A response time and eye movement analysis of bookmark recognition. In S. Fincher, P. Markopolous, D. Moore, & R. Ruddle (Eds.), *People and Computers XVIII-Design for Life: Proceedings of HCI 2004*. London: Springer-Verlag Ltd.

Appendix A: User Profiles

Appendix A: User Profiles

	User ID						
	WCITrack_2A	WCITrack_3A	WCITrack_4A	WCITrack_5A	WCITrack_8A	WCITrack_10A	WCITrack_11A
Attribute							
Academic Level	Junior, OSU	Senior, OSU	Graduate student, OSU College of Pharmacy	Vet. student OSU	Graduate Student, OSU	Graduate Student, OSU	Graduate Student, OSU
Major	Radiology technologist	Italian	pharmacy	Veterinary medicine	Business	English	Teach ESL and literature, OSU
Research	Mammography and false positives	Cultural and history of Renaissance Italy	Current studies on Grave's disease, tobacco cessation	Antimicrobial resistance in Staphylococcus species	Brad & Dunstreet, Hoovers, SEC files.	Literature of the late Jacobean period *"…so I look at lots of online plays and various texts."*	A micro-ethnographic study of multi-ethnolinguistic ESL kindergarteners' writing activities
Experience: GoogleBooks	Once	None	Some (only launch from Google)	None	None	Daily	Daily
Experience: Worldcat.org	None	None	None	None	None	Rarely (last use- 6 months ago)	Rarely (last use - 3 months ago)
Experience: GoogleScholar	Moderate (last use – 1 week ago)	None	Some (only launch from Google)	Some (only launch from Google)	None	None	Daily
Experience: Google		Daily	Secondary (PubMed 1st)	Secondary (PubMed 1st)	Daily	Daily	Daily
Gender	M	M	F	F	M	F	F

Appendix B: Tasks

Task 1

The professor for your *Climate and Weather 101* class requires that you reference at least three books in your report about the causes of climate change.

A. Find 3 books about the causes of climate change.

Condition: Discovery Search Type/Book Format

Task 2

In order to understand the controversies surrounding the Theory of Evolution, your Accessibility in Culture instructor wants you to read the following two papers or articles (but not books!):

A. 1."Darwin discovers Nature's plan" (by Sir Julian Huxley)
B. 2."A new paradigm for evolution" (by Mae-Wan Ho et. al.)

Condition: Known-Item Search Type/Article Format

Task 4

Your Accessibility in Culture instructor has told the class that there are numerous versions of "The Origin of Species" available, so she has requested a copy of the version you are using, to use when reviewing your report.

A. Find a copy of "The Origin of Species" and identify the edition information (e.g., publication date, year, etc.).
B. Using the edition information from step (A) to make sure you are purchasing the right edition, purchase a copy of the same edition for your instructor.

Condition: Known-Item/Book Format

Task 5

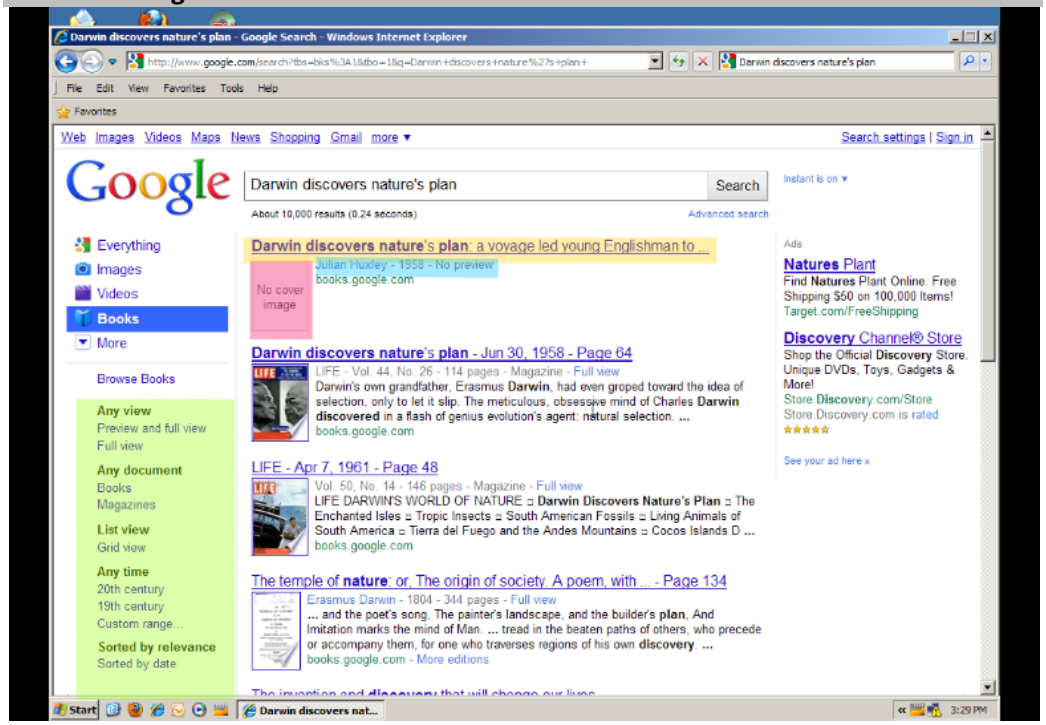
It's getting down to the deadline for your research paper about the causes of climate change! As a result, you need to complete your bibliography for the paper today.

A. Find 3 papers about the causes of climate change that are available for purchase from an online vendor.

Condition: Discovery Search Type/Article Format

Appendix C: Areas of Interest (AOI's)

AOI's for GoogleBooks



AOI's for Worldcat.org