Mark T Riddle. 'Do they look different?' An exploratory eye tracking study of whether the scanpaths of Novice and Familiar readers of graphic novels differ on the dominant/inset page. A Master's Paper for the M.S. in L.S degree. April, 2016. 81 pages. Advisor: Brian Sturm

Graphic novels, a large and growing part of the popular culture, are found across society from private homes to University Libraries.  They have been found to be of benefit to early and reluctant readers and are also used for other tasks in the private and business sphere.  As graphic novels become more popular, new forms of page layout are appearing.  This exploratory study examined how university undergraduate's eyes traveled across specific 'dominant/inset' page layouts. Participants' eye tracking data were collected using a Tobii Pro X2-30 Eye Tracker. Participants' scanpaths were analyzed using visual analysis techniques to determine how closely they corresponded to the Chronological Sequence Path set by creators.  This study found that readers more familiar with graphic novels read these pages in a smoother fashion and were less likely to revisit text than novices.

Headings:

Graphic novels

Eye tracking

'DO THEY LOOK DIFFERENT?'
AN EXPLORATORY EYE TRACKING STUDY ON WHETHER THE SCANPATHS
OF NOVICE AND FAMILIAR READERS OF GRAPHIC NOVELS DIFFER ON THE
DOMINANT/INSET PAGE.

by
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Approved by

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Brian Sturm

# Table of Contents

Contents

# INTRODUCTION

Graphic novels and comic books experienced a boom in popularity in the mid-1980s and have remained a part of the popular culture. Based on this popularity, and supported by a growing body of research, graphic novels have found their way from comic book shops and private homes into libraries and classrooms ranging from primary schools through to academic universities.  They have been found to be a benefit to reluctant readers and are an important form of multi-modal literacy and tertiary learning (Jacobs, 2013).

Reading, understanding and navigating graphic novels has been found to be reliant on the interplay of several different internal systems.  Neil Cohn and others have shown that when reading a graphic novel, readers will attempt to follow a recognized Z-Path when they can, consistent with their normal book reading methods (Cohn, 2013a). For Western culture, this means starting at the top left of the page and finishing at the bottom right; the reverse Z-path is followed by readers of Japanese Manga.  Due to the grid-like design of traditional graphic novel pages – three or four panels going across the page from the top left to top right with the next row starting back at the left again, all the way down the page – it can easily be seen how this approach to navigating a graphic novel page can be thought of as especially appropriate – See Figure A below.

**Figure A – A traditional grid-style graphic novel page taken from 'Asterix and the Olympic Games' showing The Z-path (Goscinny, 2004).**

Eye tracking research has found differences in how regular graphic novel readers (described as 'Familiars' within this paper) and newcomers or Novices to the art form will read the traditional graphic novel page. Experts or Familiars tend to read in a much smoother fashion and will skip elements of the page or panel but will have a greater understanding of the story.  Novices tend to focus primarily on the speech balloons and text.

Recently a new style of page that is not based on traditional grid design has arisen in popular graphic novels.  These pages consist of a single dominant page-sized panel with several widely spaced inset panels contained within it (See Figure B below).  These pages will be referred to in this paper as a 'dominant/inset page'.
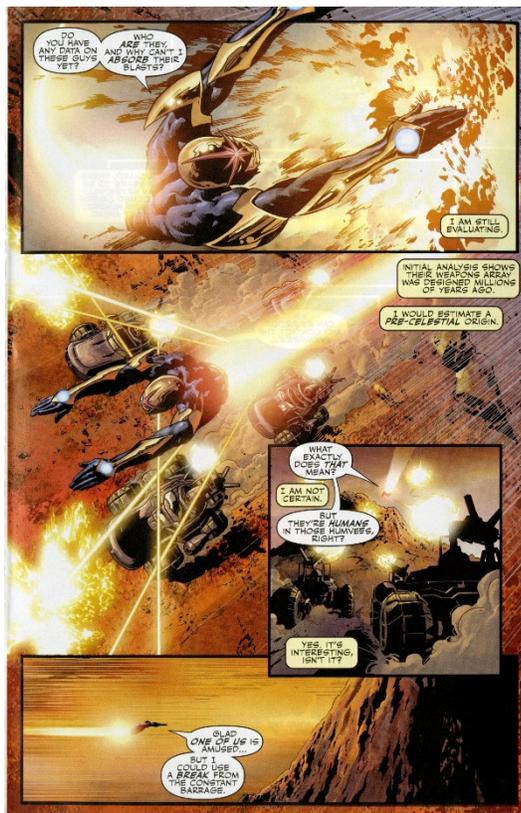


**Figure B – a full-page sized picture with three inset panels. This 'dominant/inset page' was taken from 'Secret Avengers: Mission to Mars' by Ed Brubaker and Mike Deodato.**

Research on how dominant/inset pages are read by novices or experts has yet to be carried out. With no grid structure to guide them, it was contended that novices will read these pages in a much different way than expert readers – less smoothly and taking longer to identify the Chronological Sequence Path (CSP). Using eye tracking software to record how a participant's eyes travelled across four dominant-inset panels, data including reading times and scanpaths were generated to test this theory.

As graphic novels continue to grow in popularity and change and evolve as their creator's experiment with new ways to attract new or keep existing audiences, this research study was seen as an initial exploration in determining how readers traverse these new styles of pages. Where I have found differences between how novices and experts read graphic novels I have offered potential answers as to why these occurred. These could form the basis for future research.

**Research Question:** Is there a difference between how a novice and expert graphic novel reader's eyes will travel on the dominant/inset page?

# KEYWORDS/GLOSSARY

Because eye tracking being unfamiliar to many, a selection of keywords relevant to this study have been listed below to aid in comprehension.

**Areas of Interest (AOI)**: Pre-defined areas on a testpage used by researchers for generating data such as visitation counts. AOIs are not seen by research participants.

**Chronological Sequence Path (CSP)**: The sequential path the story moves along on an individual graphic novel page, determined by the dialogue.

**Comicon**: (Comic Convention) A get-together of comic and geek enthusiasts.

**Connection lines**: Lines on a scanpath connecting fixations in numerical order.

**Double splash-page**: A layout used in many graphic novels, it uses both the left and right pages for a single, large image.

**Familiar**: For the purpose of the paper a Familiar is someone who reads graphic novels or Manga regularly. Someone with experience reading graphic novels.

**Fixation**: A place on a testpage where a participant's eyes have rested for a given amount of time. Shown in this study as a small circle.

**Novice:** For the purpose of this paper a Novice is someone who does not read graphic novels or Manga regularly. Someone who has limited experience with graphic novels.

**Reverse Z-Path**: The reading path a typical reader of Japanese will follow: right to left across the page, down to the next row and repeat until the end of the page.

**Roadsigns**: Elements of a graphic novel such as text balloons that can be used to direct where the reader's eye travels to next.

**Scanpath**: A visualization of a participant's eye movement across a testpage.  Made up of fixations and connection lines.

**Testpage**: the individual pages used by researchers when conduscting eye tracking studies.  In this case it was four dominant/inset pages.

**Z-Path**: The reading path a typical reader of English will travel on a normal page: left to right across the page, down to the next row and repeat until the end of the page

## LITERATURE REVIEW

<u>Graphic Novel History</u>

Once considered primarily the domain of children, graphic novels are now found across the public sphere (Wolk, 2007) from public schools to academic libraries (O'English, Matthews, & Lindsay, 2006). They cover topics from superheroes to national disasters, sexual health through to how to vote and American cultural history (Pustz, 2012). Movies based on graphic novels are among the top earners of the past decade (All time domestic box office results, 2016) and characters from these movies are even coming back into the prose world, (Lachenal, 2015). Public libraries have dedicated sections for graphic novels with high circulation (Ching, 2005) and comic book shop sales are breaking records (Lubin, 2014). Graphic novels are here to stay.

The first comic strip to receive widespread public attention, 'The Yellow Kid' by Richard F Outcault was a single panel cartoon in the mid-1890s. Tremendously popular, 'The Yellow Kid' was soon being used for merchandise from lunch pails to dolls to cigarette cards (Weiner, 2012). Other comic strips soon followed and in the era prior to television "Comic strips were a welcome relief in homes that otherwise had only novels as printed entertainment" (Weiner, 2012, p. 2). While many have disappeared, characters from those first comic books of the 1930s and 1940s still appear today in various formats (Gabilliet, 2010) – including high grossing movies in 2016 (2016 Domestic Grosses, 2016). Comic strips themselves have been recognized as being such as important

part of American culture that the United States Postal Service has released commemorative postage stamps of popular characters (Crawford, 2006).

Culturally, comic strips have been used in other ways such as tools for propaganda. Captain America punched out Hitler (Scott, 2007), and 'The Phantom Goes to War' by Lee Falk, which originally had the titular character fighting the Japanese in 1943, was repurposed only seven years later to fend off a Korean invasion in 1951 (Patrick, 2012).

Despite being used for evoking nationalistic pride and fervor in the 1940s, comic strips had a contentious history over the next few decades, at times being pursued by McCarthy-Era censorship (Witek, 1989). Even today, with hordes of research studies praising graphic novels and their use across society, individual titles still find themselves under attack and are frequently challenged in popular culture. The American Library Association's list of banned books includes several graphic novels and in mid-2015 students at Duke University complained vociferously about being asked to read a graphic novel, 'Fun Home' by Alison Bechdel due to its alleged pornographic or inappropriate content (Romano, 2015).

A key part of several counter-culture movements in the 1960s and 1970s, graphic novels 'held on' in the public gaze until the mid-1980s when a flood of popular books received critical acclaim (Gabilliet, 2010). Books such as 'The Contract with God and other Tenement Stories' (Eisner, 1996) - the recognized first title to use the term graphic novel, 'Watchmen' (Moore, 2008), 'Batman: The Dark Knight Returns' (Miller, 2002), 'Maus' (Spiegelman, 1986) and 'Persepolis' (Satrapi, 2003) continue to not only be read but form part of university book lists and required reading across the United

States of America (Weiner, 2013). Graphic novels based on web comics, bound collections of monthly comic books and those designed and released as standalone books can be found in bookstores across the nation and are selling well (McGrath, 2004). With this type of popularity and influence on the public consciousness, it is clear that graphic novels are no longer a frivolous 'funny book' but a legitimate part of today's popular culture.

Graphic Novel Use Today

In addition to being part of popular culture, research indicates that graphic novels can be of immense use in teaching. Graphic novels, through their inherent nature of being a multi-modal text (Jacobs, 2013), have been found to be beneficial not only to beginning readers (Karp, 2012), but also reluctant readers (Snowball, 2005) and English as a Second Language learners (Chun, 2009). Graphic novels are used to teach business concepts (Short, Randolph-Seng, & McKenny, 2013) and expert decision-making (Nalu & Bliss, 2011). An additional benefit aside from their popularity is their ability to be used to effectively to cover a wide array of topics. While graphic novels or comic strips are still spreading across Western culture, they have been a long established part of Japanese culture. Japanese comics or Manga have covered diverse areas of life for decades (Allen & Ingulsrud, 2007). Therefore, with graphic novels being both popular and useful to societies across the world, it is important to understand how readers, whether experienced or inexperienced with graphic novels, interact with both traditional and new forms of the art.

How graphic novels are read

The definition of a comic by pioneer researcher Scott McCloud (1993) is "juxtaposed pictorial and other images in deliberate sequence, intended to convey information" (p. 9).  A comic book/graphic novel page or panel is made up of many diverse elements including images, speech balloons, narration boxes, symbols of the trade such as motion lines and word-art, and even the blank gutters surrounding the individual panels.  With so many different elements working together, there have been numerous theories put forward as to how the reader interprets the page.  Researcher Neil Cohn (2014) stated that the:

> "growing literature of both theoretical and empirical research has established that extracting meaning from a comic page involves multiple interacting systems, analogous to the organization of a linguistic system: A *graphic structure* encodes the physical lines and shapes that compose the images, which construct meaningful expressions using a *lexicon* of stored graphic schemas. A *narrative structure* organizes these sequential images into a coherent message, while an *external compositional structure* arranges these panels across the physical layout of a page". (p. 1)

This research study focused on the external compositional structure of a newly described graphic novel page: the dominant/inset page, while examining how our participants interpreted the narrative structure.

Novice readers of graphic novels are thought to follow the Z-Path as they travel the graphic novel page – left to right across the page, back to the next point on the left and across to the right and so on finishing at the bottom right corner – as they would on the page of a regular book.  Readers of Japanese Manga instead follow the reverse Z-path, the same as a Japanese novel (Cohn, 2013b).  However, the individual layout of pages within a graphic novel can be very diverse, moving from the traditional grid design

to layouts that place panels in ways that may confound novice readers (Cohn, 2013a). In Cohn's research on grid layout, participants were given blank comic books with several different iterations of the grid format, and asked to number what order they would read them in.  Importantly, this research found that separating panels – placing large spaces between them, or staggering them vertically – could entice readers to leave the traditional Z-path.  This does not however have an impact on reading comprehension (Omori, Ishii, & Kurata, 2004).  The dominant/inset pages in my study featured both separation and staggering, however rather than there being the large empty space of a gutter, the pages instead had a colored background making up a complete picture (See Figures D through G in the Methodology section).  Cohn's study looked at how readers encounter inset panels and found that they would first look at the dominant panel and then the inset.  Whether this would be the case for the dominant/inset page was a key element of this paper's research. A limitation of Cohn's study was that it used only blank panels without the traditional other elements present.  A further limitation was that the participants were recruited from amongst attendees at a ComiCon and as such even those declared as novices may have had a better knowledge or familiarity with graphic novels than a true novice.

However, it is not just panel order that shows readers where their eye should travel to next.  Manga illustrators and writers guide their readers through the page using the subject and speech balloons (Folse, 2010).  The use of these individual elements of the page are described as "road signs" (Cao, Lau, & Chan, 2014) conveying not only their inherent meanings to the reader, but showing them how to read the page.  All the decisions made by the co-creators in terms of placements of the individual elements and

decisions on color, shadow and emphasis impact on how the reader will experience the graphic novel page. In the paper "Strategies used by children when reading Manga" (2007), Allen found that children on their initial reading of a graphic novel focus mostly on text balloons and faces of the characters, as these acted as the primary road signs for their readers. Self-expressed limitations of Allen's study were that it was not done under experimental conditions, and was performed by having participants trace with felt-tip pens where they *thought* (emphasis mine) their eyes were going. To overcome this particular limitation, the current research project instead used an eye tracking methodology.

Eye Tracking Studies

One of the benefits of eye tracking is the sheer amount of data that can be collected (Raschke, Blascheck, & Burch, 2014). Scanpath visualizations (showing how eyes travel) and heat maps (showing how long eyes stay at a particular point on the page) are two of the most commonly used ways of analyzing these data. Heat maps were discounted for use in this research, as I was more interested in where the eyes of my participants travelled rather than how long they stayed on the one point on the page.

A key issue with using scanpath visualizations is that they suffer from visual clutter – fixations appear frequently as the eyes travel across the page. Many fixations result in many connection lines, and these can make it difficult or even impossible to see the overall pattern. However, by the use of pre-determined Areas of Interest (AOI), researchers can instead look at scanpaths based on how the reader move from one AOI to the next (Raschke et al., 2014).
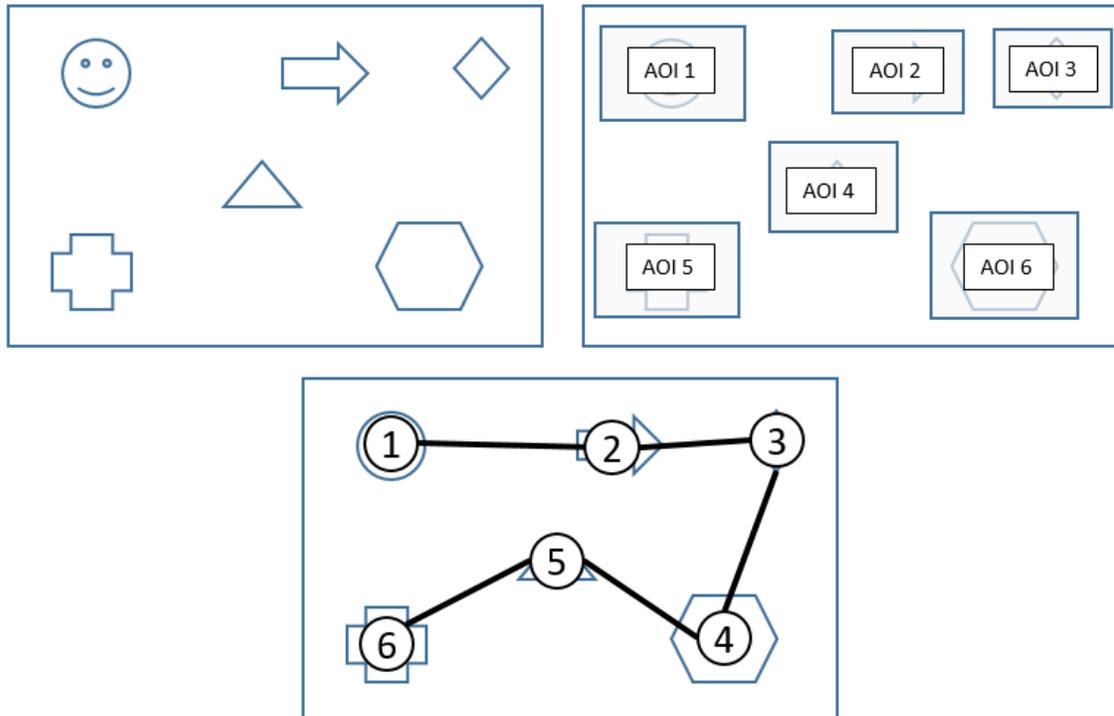
**Figure C – Examples of AOIs on a testpage.**

The above collection of images (Figure C) was generated to assist in the understanding of the use of AOIs. The first image shows a testpage with a collection of six shapes. The second image shows the shapes with AOIs drawn on top of them – these are used by researchers for analysis but are not seen by participants. These AOIs have been numbered in an order that posits participants will follow a Z-path when looking at this testpage. The third image shows the path that a fictional participant's eyes took when viewing this page. Following the recording and analysis of the eye tracking data in this fictional study, it can be seen that the participant started by looking at the smiley face (1), moved to the arrow (2), and followed this to the diamond (3), down to the hexagon (4), up to the triangle (5) and finished at the cross (6). As can be seen, this participant did not look in the same order that the fictional researcher expected. Examples of how the

placement of AOIs was determined and how the visual analysis was carried out in my study can be seen in the Methodology section.

Eye Tracking Studies and Graphic Novels

Eye tracking studies using graphic novels and comic books have been fairly limited but some important discoveries have been made.  Eye tracking studies have verified that comic book artists are successful in controlling viewer attention and controlling where the eye should go (Jain, Sheikh, & Hodgins, 2012).  Studies have also shown perceived differences in how an expert or a novice reader of graphic novels will read the page (Cohn 2013b; Nakazawa, 2002).

Research using eye tracking to study how people look at advertisements found that "the goal of the viewer very much influences where (and for how long) viewers look at different parts of ads, but also indicate that the nature of the ad per se matters" (Rayner, Miller, & Rotello, 2008, p. 697).  As experts and novice readers can be said to have different goals when reading a graphic novel in terms of comprehension, Rayner et al.'s study supports my contention that the scanpaths generated in my study would differ significantly.

<u>Conclusion</u>

Graphic novels form an integral part of today's culture and are of use in a wide variety of entertainment and educational settings. To successfully navigate the graphic novel page, readers must interact with a range of different internal systems when interacting with the multimodal text. Readers will attempt to follow the recognized Z-path where possible and will use road signs placed by the co-creators to guide them through the page and its CSP. However, new formats and layouts of graphic novel pages, such as the dominant/inset page, have yet to be studied using eye tracking methodologies leaving questions as to the differences in how a novel or familiar reader will interact with these pages.

## METHOD:

<u>Test Page Selection</u>

A key decision in this research design process was choosing the four dominant/inset testpages.  Originally four pages from separate graphic novels were planned to give diversity among the testpages but I instead decided to use pages from a single story to limit differences in illustration, lettering and coloring style.  This was also to give a more natural reading experience and to lessen confusion for participants who would now only have to interact with a single, rather than multiple plotlines.

Several books were studied with an eventual decision being made to use four consecutive pages taken from 'Secret Avengers: Mission to Mars' by Ed Brubaker and Mike Deodato.  This particular set of pages was chosen as they

i)      appeared consecutively;

ii)     had different configurations of the dominant/inset page;

iii)    had no more than four inset panels per page;

iv)     were all full-color;

v)      all occurred in a single story arc without jumping to other characters or settings;

vi)     were unlikely to have been read by any participant before while still retaining familiar characters.

By appearing consecutively and being part of a single story arc across 10 pages, this limited the amount of time a participant's eyes would be tracked and the length of time they would be required to sit in the same position. This decision was made to limit the number of times the participant would have to be reminded to return to the calibrated position. Secondly it allowed the recording of data to begin at page 1 of the excerpt and to finish at page 10. This lead to less interaction between myself and the participants, and gave them more control over their reading experience, as I did not have to interrupt them to start and stop the data recording. Testpages A through D made up pages 4 to 7 of the mini-story and while data for pages 1,2, 3, 8, 9 and 10 were recorded, they were not analyzed for the purposes of my research study.

Another benefit to these 10 pages being selected was that the story revolved around the same characters (with an unstudied double splash-page flashback) and did not jump to other settings or characters potentially confusing participants.

Having four different configurations of the dominant-inset panel allowed for greater diversity among the test pages. For each testpage I drew the chronological sequence path (CSP), based primarily on the dialogue. As Figures (D-G) below show, four very different CSPs were present on these pages. For the purposes of this study, Testpage A's CSP is described as a 'Reverse N', with Testpage B and C's CSPs resembling a 'Shepherd's Crook'. Despite being a dominant/inset page, the CSP of Testpage D follows a 'Z-path'.

AOIs were generated for each of the four testpages to allow statistics such as visitation counts and times to be generated by the Tobii Studio Pro Software (described further on in the Methodology). These AOIs were generated by drawing a box around

the text bubble, or bubbles if they were very close to each other which was then expanded

by 50 pixels in each direction to allow for some calibration errors.  Each AOI was then

given a number based on its place in the CSP.  AOI 4 on Testpage D was the only AOI

not based on a text bubble as it consisted of a panel with no accompanying dialogue.  It

was instead centered on the figure of Nova as he was judged to be the focus of the panel

(see Figure AD in the Results section).

**Figure D – The path shows the CSP for Testpage A.  A 'Reverse N'.**
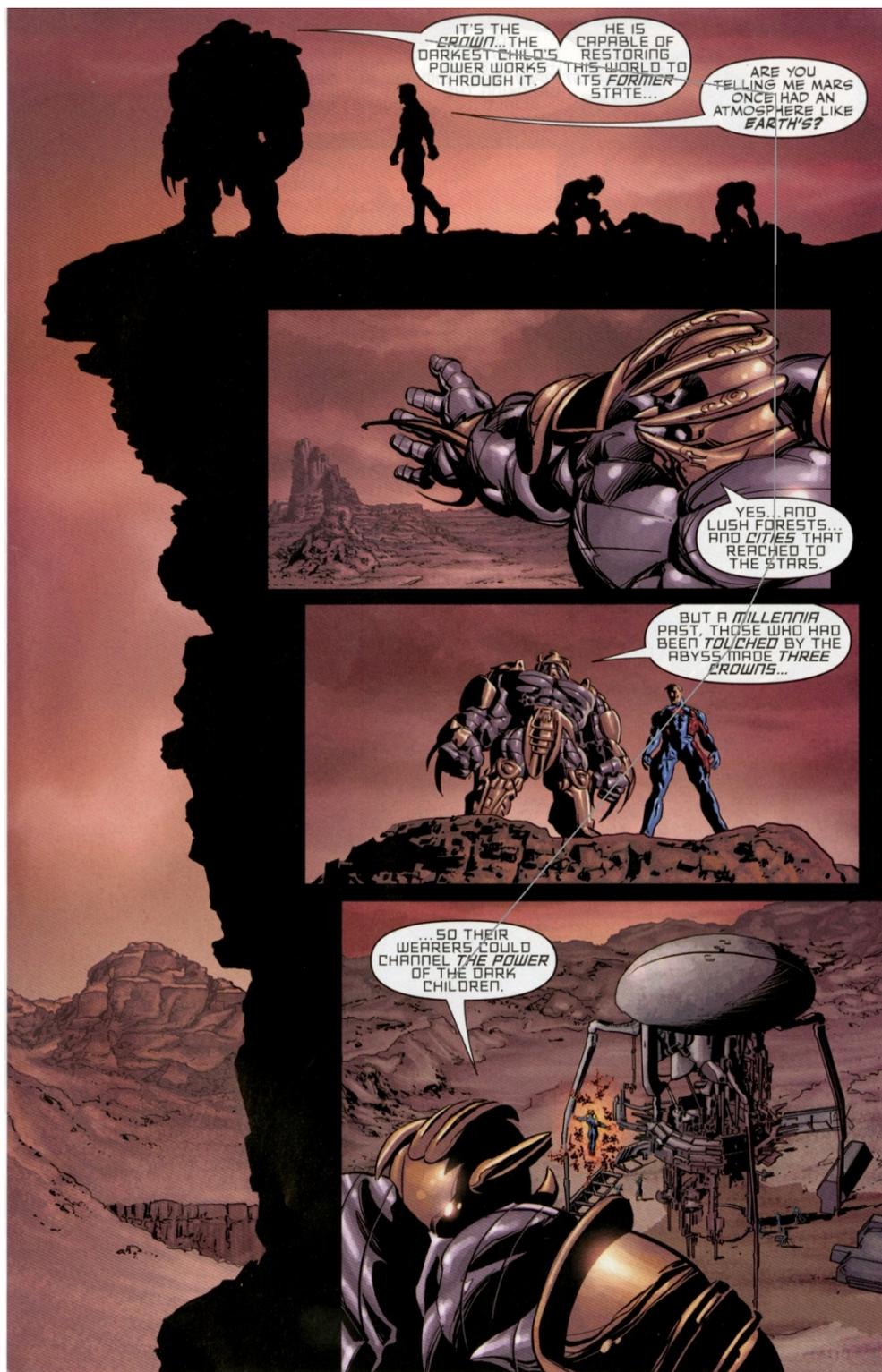
**Figure E – The path shows the CSP for Testpage B. This CSP is described as a wide 'shepherd's crook' shape.**

**Figure F – The path shows the CSP for Testpage C.  Similar to Figure E, this CSP is a tighter 'shepherd's crook'.**

**Figure G – The path shows the CSP for Testpage D.  A 'Z-path'.**

Recruitment

Participants were recruited via two methods – a presentation to a large seminar undergraduate class (Appendix A) that yielded two participants, and then through the use of flyers placed in Manning Hall, Greenlaw Hall and the Undergraduate Library at UNC at Chapel Hill (Appendix B).  Once initial email contact was made, participants were asked to self-report their familiarity with graphic novels and times for interviews were set.  Participants were paid $15 to take part in the study, with $5 being awarded if they could not be calibrated to the Eye-Tracker (This did not occur, however as discussed later, three participants eye tracking data were removed during analysis due to recording/calibration issues).  While initially it was thought that recruitment via email or snowball sampling might be required to find sufficient participants this was not the case, due to an enthusiastic response to the flyers.

A total of 18 undergraduate participants took part in the study, 12 females and 6 males.  Of these participants six females and three males self-described as novices when reading graphic novels with six females and three males describing themselves as being familiars.  Each case, including both the eye tracking test and post-test semi-structured interview took around half an hour.

Apparatus

The Tobii X2-30 Eye Tracker was used for this study, a machine designed primarily for gaze point research.  It consists of a small device connected to a desktop or laptop computer via a single USB port and is less distracting and a more natural experience than eye tracking devices that attach to the head or require a chin mount. The Tobii X2-30 Eye Tracker works using infrared diodes that generate reflecting patterns on

the subject's corneas.  These patterns are reflected back to the apparatus and then

analyzed using a variety of filters (Tobii 2016).  The Tobii Pro Software package 3.3.1

was used to record and analyze the data for this study. I chose to use the I-VT filter

default settings as the "default values of the I-VT fixation filter parameters have been set to

provide accurate fixation classifications for the most common eye tracking use cases, e.g. web,

market research and standard reading studies" (Tobii 2016, p. 54).  The I-VT filter works by

classifying eye movements:

> "based on the velocity of the directional shifts of the eye.  The velocity is most
> commonly given in visual degrees per second (°/s). If it is above a certain threshold the
> sample for which the velocity is calculated is classified as a saccade sample and below it
> is seen as part of a fixation" (Olsen 2012, p. 5).

The default settings for the I-VT Filter as part of Tobii Studio 3.3.1 sets the

Velocity Calculator Window Length at 20ms and the I-VT classifier has a velocity

threshold of 30 degrees/second.  Adjacent fixations were merged with a max time

between fixations of 75ms and a max angle of 0.5 degrees.  Short fixations were

discarded with a minimum fixation duration of 60ms.

When a scanpath is generated it shows the fixations linked by connection lines.

Fixations appear as small circles, which can either be drawn as all the same size as can be

seen in Figure H below or can be scaled for duration of gaze as in Figure I.

The four testpages, were viewed on a 17 inch monitor with a screen resolution of

1680 x 1050 pixels.  Testpage A was sized at 639 by 1000 px, Testpage B was 645 by

1000 px, Testpage C was 642 by 1000 px and Testpage D was 644 by 1000 px.

**Figure H - Testpage C showing the scanpath of Subject 6 with all fixations at the same size.**
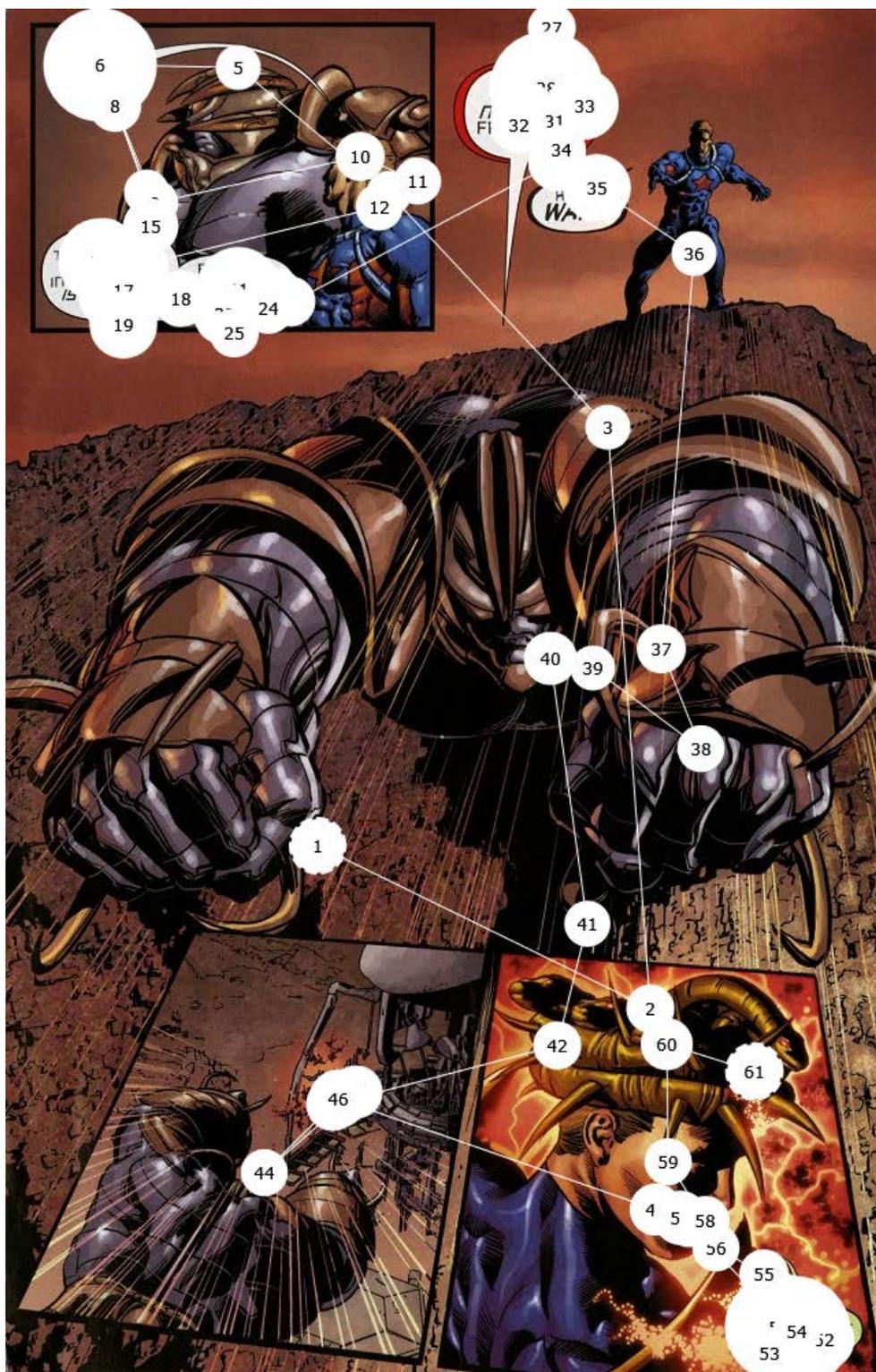
**Figure I - Testpage C showing the scanpath of Subject 6 with the fixations scaled for duration length.**

Procedure

Prior to the study proper, a pilot study was conducted to determine best methods of providing as natural as reading experience as possible, and ensuring optimal lighting for using the tracker. Despite being a mobile Eye Tracker able to be used in a variety of locations, the Tobii X2-30 was instead used in the Eye Tracking Lab on the UNC campus which is a recognized limitation on a natural reading experience. As a new piece of hardware it was being kept in-house for all researchers at the time of the study. When conducting the study itself, each participant was shown the cover of 'Secret Avengers: Mission to Mars' and introduced to the characters they would see in the story (Appendix C). They were then read a short synopsis of the events (Appendix D) prior to the story so as to limit confusion once recording began.

The Tobii X2-30 was then calibrated after having the participants sit comfortably between 50cm and 70cm away from the screen. The Tobii X2-30 allows some head movement [50 x 36 cm at 70cm from screen] (Tobii 2014), but throughout the session I was on hand to remind the participants to keep from slouching and try to keep their head in the same position as during calibration. In an effort to reduce distractor variables, I sat silently out of view of the reader, viewing their recordings on a secondary screen. The only interaction occurred if the participant needed reminding to sit in the calibrated position. In order not to interrupt the reading experience, data recording began immediately after calibration. Each participant read three pages of the graphic novels on screen prior to the selected text pages in order to give context to the story and provide a more natural reading experience. Page turning was controlled by the participants giving a

single click of the mouse. The additional recorded data were not analyzed for the purpose of this study but may form the basis of future research.

Following the eye tracking, a short semi-structured interview was carried out with the participants (Appendix E) in order to gain information on what they *thought* they did during the study – with most interviews being between four to five minutes long. These interviews were then transcribed and analyzed for trends.

Analysis

Upon completion of the data collection process, a total of 72 scanpaths (four test pages for each of the 18 participants) were generated for review. Three participants – Subjects 5, 15 and 16 had their data removed immediately for the following reasons. S5, a female novice participant, had several fixations that were recorded off the page and so her data were removed. Despite initially calibrating successfully, S15's scanpaths were congested in the top left corner of the page – see Figure K below. S16 was shown to have only recorded four to 13 fixations per testpage which was interpreted as a recording error. Both S15 and S16 were classified as female, familiar participants. Despite their eye tracking data being removed, I included all three participants' input from the semi-structured interview phase as it was being used as a guide to what participants thought they did, rather than their actual actions. This left the study with a total of eight novices – (five females and three male) and seven familiars – (four females and three male).

Initial analysis was carried out by generating tables of the time taken to navigate each page and the number of fixations recorded by each participant.

Visitation count statistics were then generated using the Tobii Pro Software package. However, when comparing the scanpaths to visitation results it was found that

due to the granularity of results being required and how small some of the AOIs

remained, a small calibration error could lead to badly skewed results.  S14 in particular

had calibration errors at the top of the page, which can often occur in eye tracking studies

(Holmqvist, 2011) and so was recording seven visitations to AOI 1, despite all fixations

being tightly clumped together.
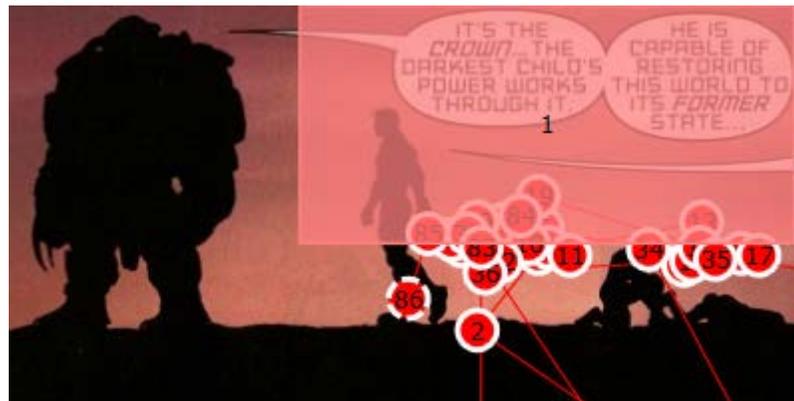


**Figure J - As can be seen, this calibration error generated several extra visitation counts to AOI 1.**

To overcome this error, each scanpath was viewed individually in real time.  Each

participant's visit to an AOI was recorded (see Tables 6 through 9 in the Analysis of AOI

Visits section of this paper as well as Appendix G), generating a list which showed each

instance a participant visited an AOI and in what order.  This list was then examined to

determine whether and how quickly a participant discovered and kept to the CSP and

whether they revisited the AOIs after completing the sequence.  While this is not a

perfect solution, it is an unfortunate outcome from using the Tobii X2-30 and using

professionally drawn testpages with sequential text balloons/AOIs too close to each other.

In the future I would use specifically designed testpages and if possible recruit more

participants so as to be able to keep only participants with excellent calibration.
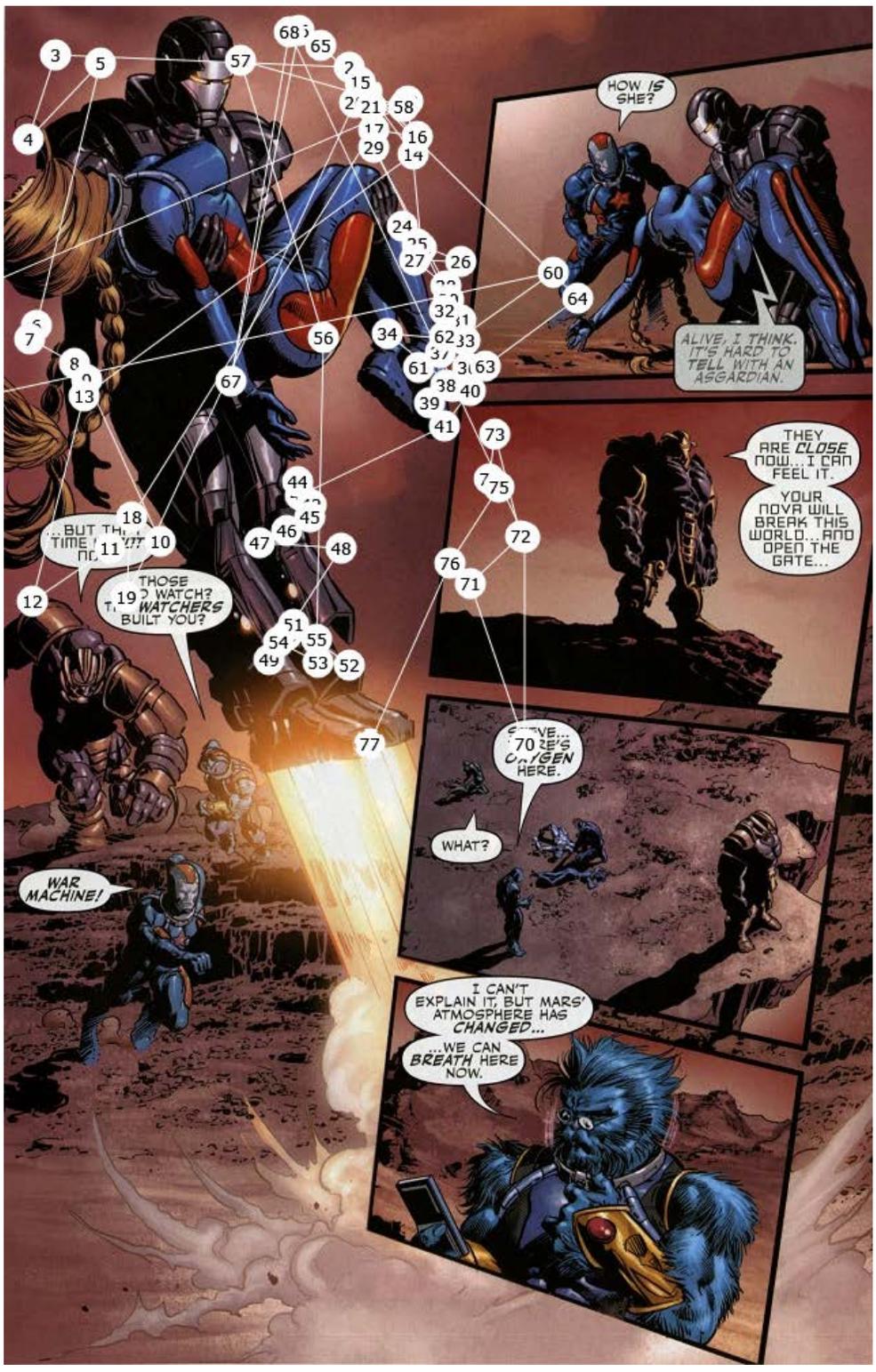
**Figure K - Testpage A showing the scanpath of Subject 15, showing how the calibration was skewed towards the top left.**

## RESULTS

<u>Groups</u>

Due to the difficulties in scheduling times for individual tests, the Novices and Familiars

could not all undertake the tests in a sequential order.  The two groups and their sexes can

be seen in Table 1 below.  To help with comprehension of all of the following tables,

Novice participants and their results will be in plain text, while Familiars will be in

*italics*.

**Table 1.**

| Subject Number | Gender | Group |
|---|---|---|
| S1 | F | N |
| S2 | F | N |
| S3 | M | N |
| S4 | M | N |
| S5 | F | N (Removed) |
| S6 | M | N |
| *S7* | *F* | *F* |
| S8 | F | N |
| S9 | F | N |
| S10 | F | N |
| *S11* | *F* | *F* |
| *S12* | *F* | *F* |
| *S13* | *M* | *F* |
| *S14* | *M* | *F* |
| *S15* | *F* | *N (Removed)* |
| *S16* | *F* | *N (Removed)* |
| *S17* | *M* | *F* |
| *S18* | *F* | *F* |

Initial Time and Fixation Analysis

The initial form of analysis carried out was to first compare the average page completion time and fixations of the two groups of participants. Table 2 shows the averages of each while the individual times and fixations for each participant can be seen in Appendix F.

**Table 2.**

| Participant Group | Testpage A Ave. Time | Testpage A Ave. Fixations | Testpage B Ave. Time | Testpage B Ave. Fixations | Testpage C Ave. Time | Testpage C Ave. Fixations | Testpage D Ave. Time | Testpage D Ave. Fixations |
|---|---|---|---|---|---|---|---|---|
| **Novices** | 32.30 | 91.33 | 27.40 | 82.22 | 29.48 | 85.11 | 20.20 | 60.11 |
| **Familiars** | 26.58 | 70.72 | 24.35 | 70.43 | 22.45 | 64.71 | 17.18 | 47.71 |
| **Difference in secs/ fixations** | 5.72 | 20.59 | 3.05 | 11.79 | 7.03 | 20.4 | 3.02 | 12.39 |

As can be seen, the Novice group took longer to navigate each page – between 3.02 and 7.03 seconds on average and had between 11.79 and 20.59 more fixations. Due to the novelty of reading graphic novels and unfamiliarity with graphic novel conventions, this was an expected result.

Testpage A

Testpage A took the longest and had the most fixations for both groups. It was noted in the interviews following the eye tracking activity that many participants struggled with Testpage A, perhaps because it had the most challenging CSP – the 'Reverse N'. Several participants mentioned this page as being difficult to begin.

> "They like had a full picture on the left side and then they had like four panels going down on the right, I was like I don't know what order I should read this or if I should take as occurring at the same time, so I paid more attention to the picture that was continuous versus the one that was broken up four times" – S2.

Subject 3 echoed similar sentiments that this page "took me a while to get an idea where

to start".  Some members of the Familiar group also mentioned this page as being

difficult in particular as it had text in the top right corner (See Figure L below).



**Figure L – showing the text in the top right corner of Testpage A**

S12, whose primary experience with graphic novels is Japanese Manga, said that

"With Manga you know you have to read it backwards [the reverse Z-path], so I
kind of went back to that when I was reading this one a little bit. I kind of forgot
that this is the American style so you just read normally … I corrected myself. It
started not making sense so I was like wait, wait, wait go back so I reread it."

S14 said he remembered that on Testpage A "I was reading the top right first but I

realized that …War machine hadn't appeared yet."  In this instance I believe that being

familiar with a 'different normal' caused some confusion, however these participants

were able to overcome this and quickly rediscover and re-enter the CSP.

Testpage B and Testpage C

Testpage B and Testpage C had similar 'Shepherds Crook' CSPs; however, they

recorded differing results from both groups.  The Familiar group was more at ease with

Testpage C than B – taking less time and recording fewer fixations – but this was

reversed for the Novice group. The major difference between these two pages is that on

Testpage C the text bubbles are placed outside the panel borders (See Figure M).



**Figure M – Showing the text bubbles outside of the panel borders**

I believe that once the Familiar group had 'reset' themselves from the confusing

'Reverse N' page of Testpage A, they were able to more easily traverse two similar pages

– the large-scale familiarity of design between the two pages worked to their advantage.

However, the placing of text bubbles outside the panels could lead to greater confusion

amongst the novice group as they tried to find the CSP of these pages. In the interview

stage, participants from both groups discussed reading the text, looking at the pictures

within the panels and then moving to the next panel. With the text/road signs *outside* the

panel I believe the Novice group may have found it more difficult to know where to

move to next in the chronology.

This is further discussed in the Initial Visual Analysis section below.

Testpage D

Both groups spent considerably less time and had fewer fixations navigating

through this page. As this page follows a Z-path CSP I was not surprised by this result.

Every participant when asked to describe how they navigated this page described a Z-path – with some believing that they may have initially started with the large central figure (Archon) before moving up to the top left. This is discussed further in the Initial Visual Analysis section below.

Initial Visual Analysis

Figures N through O show Testpages A through Testpage D with the completed scanpaths of all included participants. The Novice group are the white fixations while the familiar group are the red fixations. These have been included to highlight several aspects of the research as a whole.
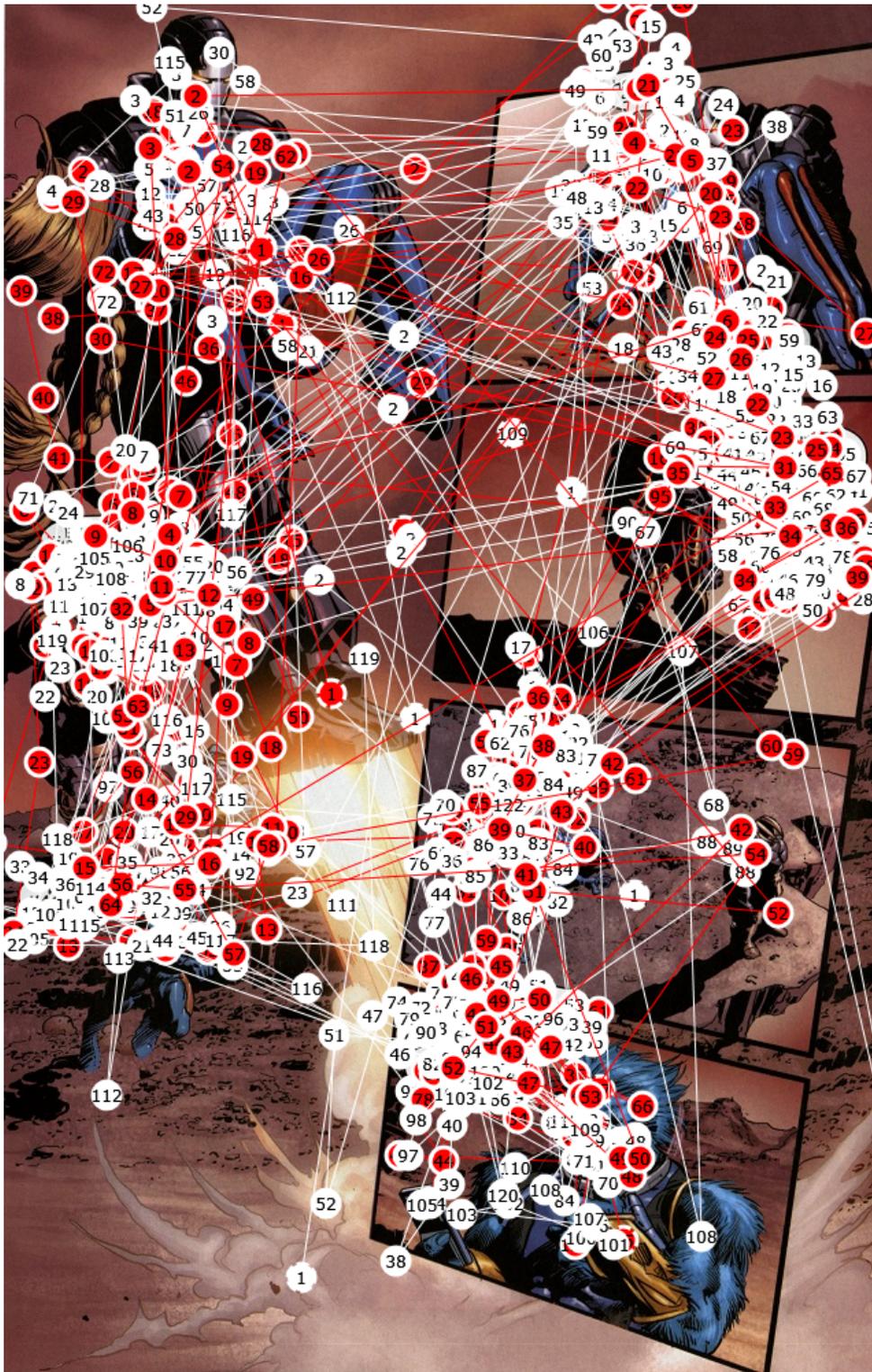
**Figure N – This shows the combined scanpaths of all participants on Testpage A. The novice group scanpaths are white, while the familiar groups are red.**
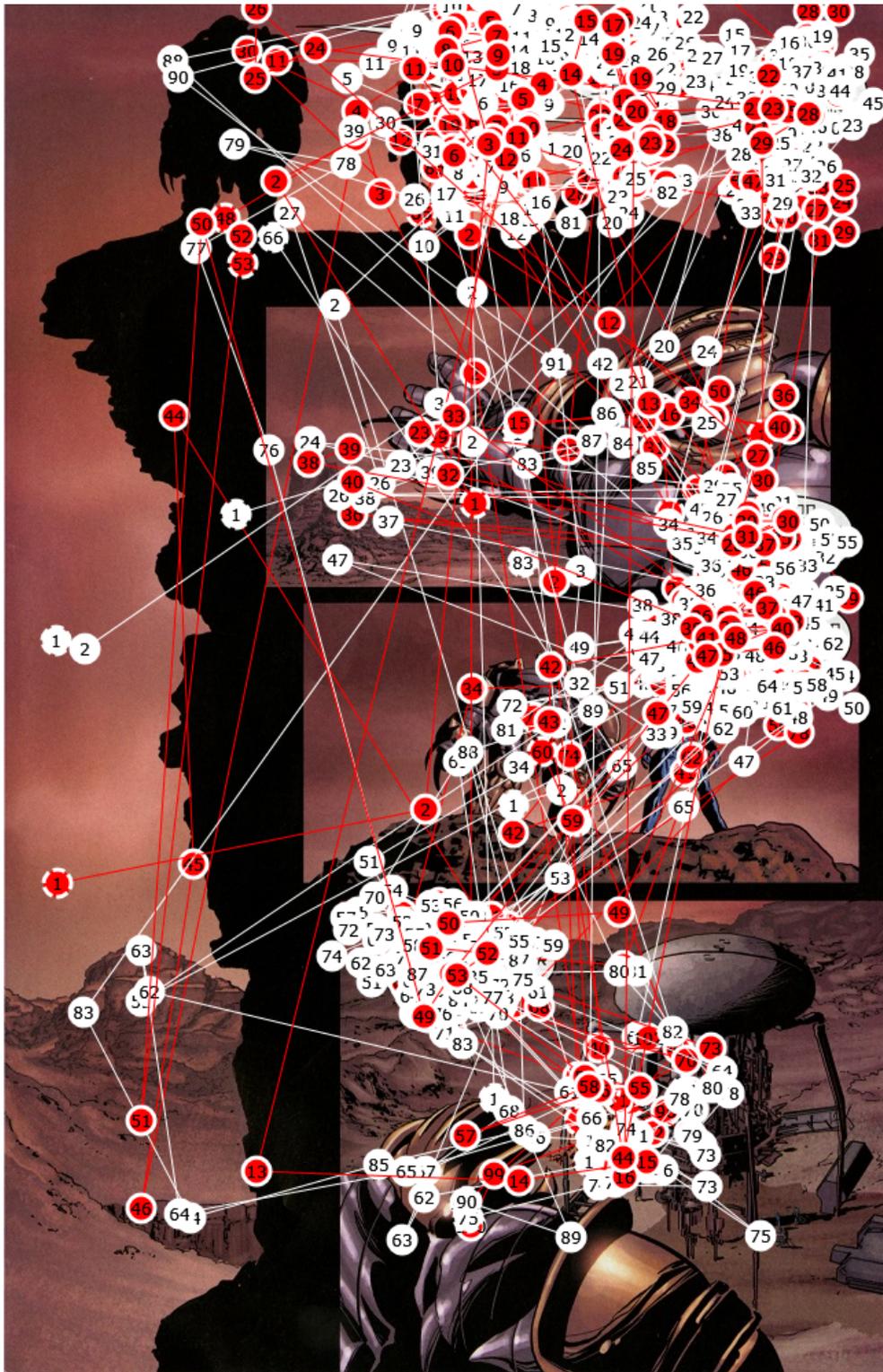
**Figure O – This shows the combined scanpaths of all participants on Testpage B. The novice group scanpaths are white, while the familiar groups are red.**

**Figure P – This shows the combined scanpaths of all participants on Testpage C. The novice group scanpaths are white, while the familiar groups are red.**
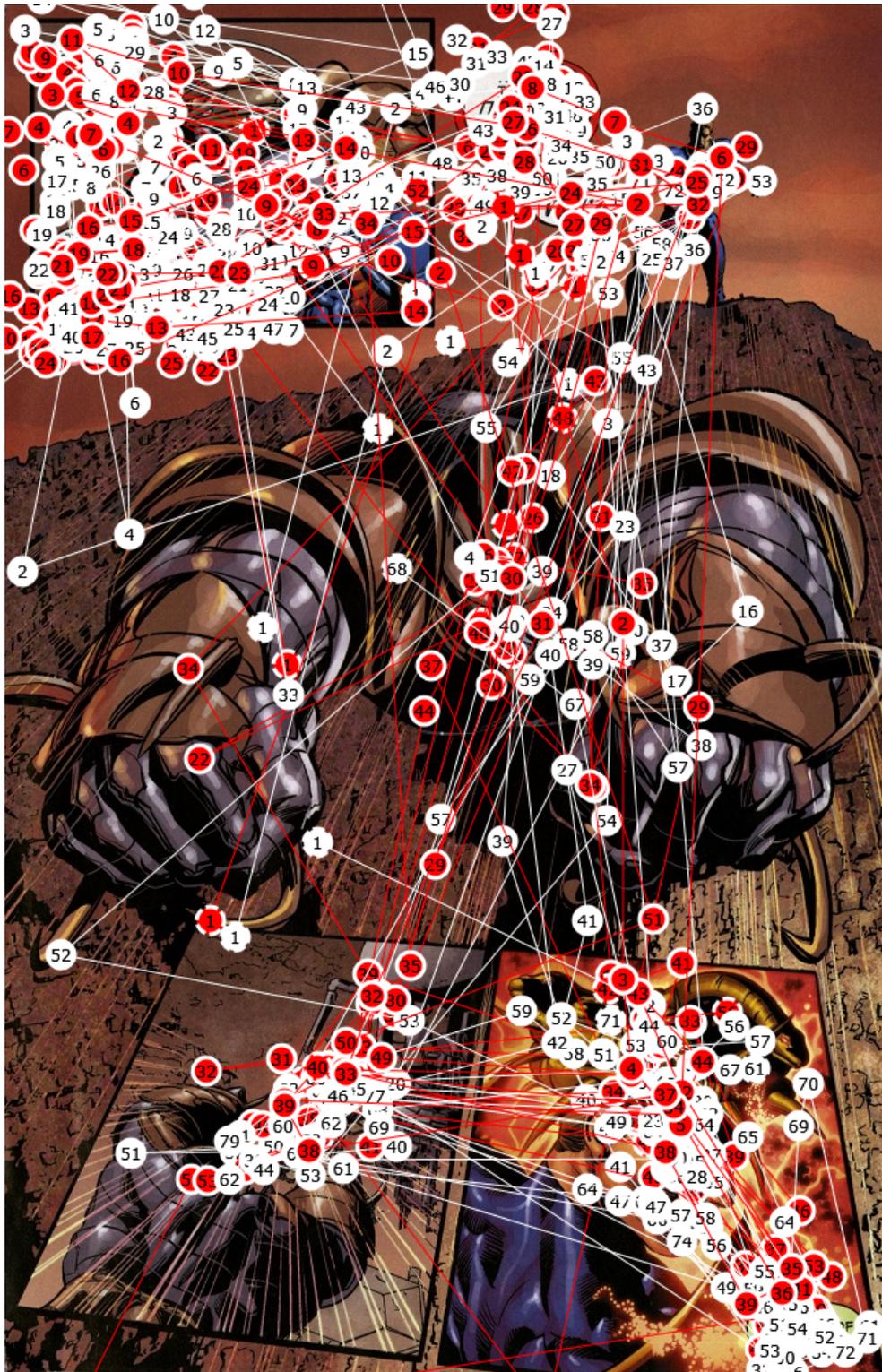
**Figure Q – This shows the combined scanpaths of all participants on Testpage D. The novice group scanpaths are white, while the familiar groups are red.**

From even a cursory glance it can be seen that these scanpaths show that there were more fixations from the Novice group as is highlighted in Table 1, however it also shows the similarities between the two groups.  The vast majority of fixations are clumped together – centered around the AOIs and other expected points of interest such as faces.  The scanpath format was chosen over heatmaps as it allows ease of comparison between the two groups.  This initial Visual Analysis was carried out to give understanding to the Analysis of AOI Visits section that follows.

The next set of figures shows the scanpaths of the two participant groups separately to allow for visual comparison.  The Novice scanpaths were altered in color for this section as the white trajectory lines would not show up on the page.

Testpage A
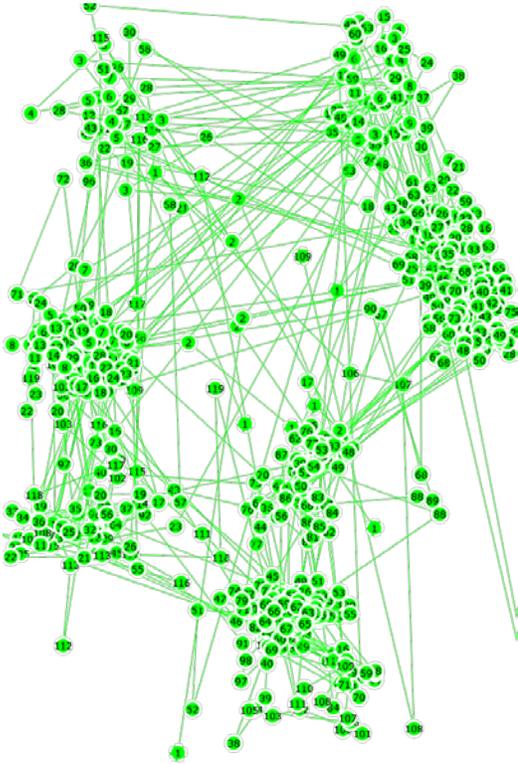


**Figure R – Nov. scanpath Testpage A**          **Figure S – Fam. Scanpath Tp. A**
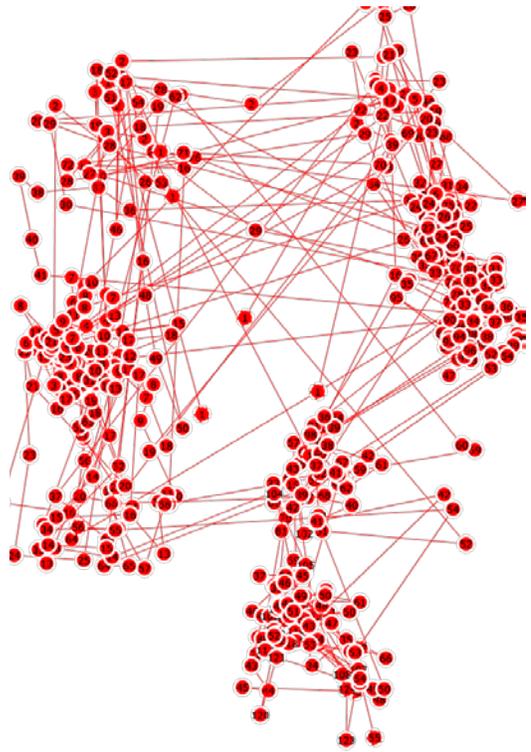
Looking at the two scanpaths above, particularly the connection lines, it can be seen there is less lateral (side to side) movement in the Familiar Figure (Figure S) than in the Novice – (i.e. there are fewer red lines across the middle of the diagram for familiars than there are green lines for the novices). It can also be seen that there are fewer fixations in the very middle of Testpage A for Familiars.

Testpage B
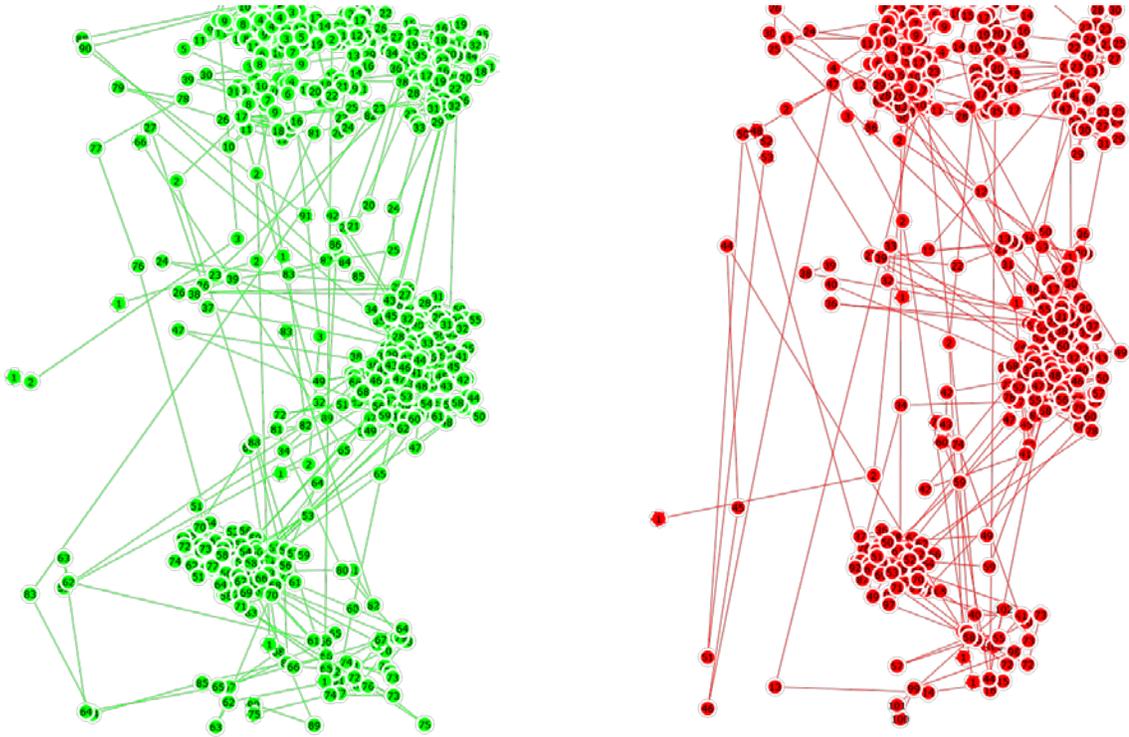


**Figure T – Nov. scanpath Testpage B     Figure U – Fam. Scanpath Testpage B**

These two scanpaths are very similar which in light of the results discussed in the Initial Visual Analysis section is not surprising.  Testpage B's difference in average time between the two groups was only just over three seconds and the difference in number of fixations was the smallest at only 11.79 per path on average.  It is interesting that on this page it seems that there appears again to be less lateral movement in the Familiar figure however there are several fixations away from the 'clumps' in both.

Testpage C
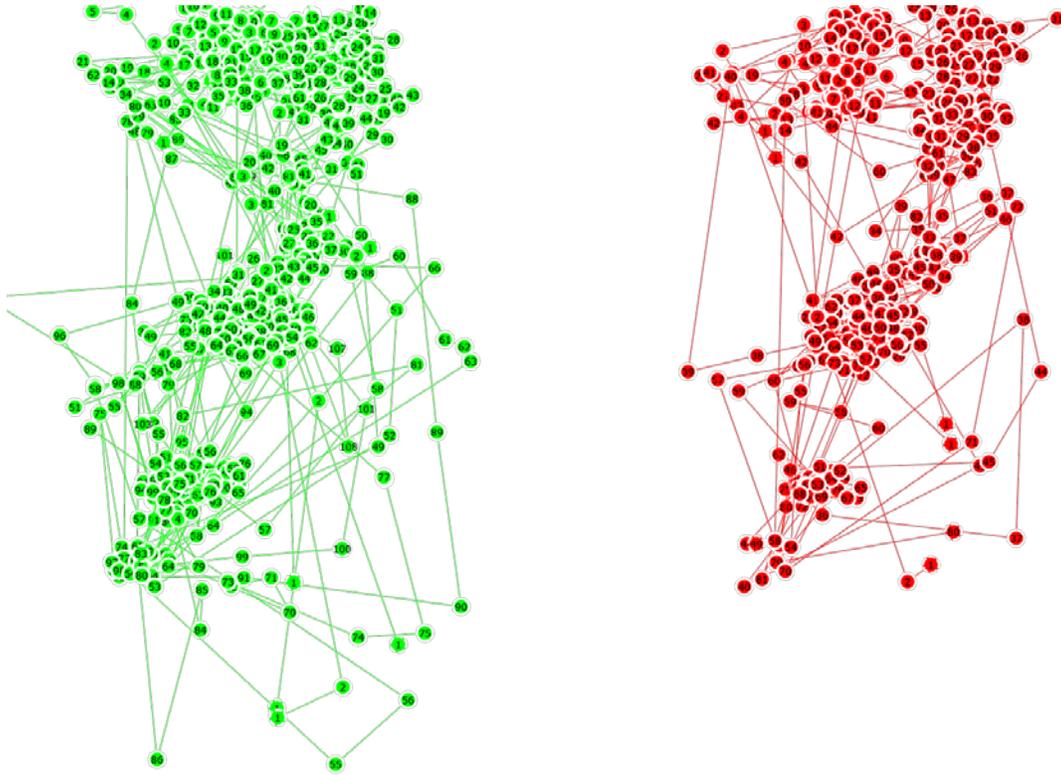


**Figure V – Nov. scanpath Testpage C        Figure W – Fam. Scanpath Testpage C**

It is very easy to see in this side by side analysis that the Familiar scanpaths were tighter than the Novices', focused more on the AOIs and had very little deviation away from the 'Shepherds Crook' design.  As discussed in the Initial Visual Analysis section above, on this page the Familiars were much faster and had fewer fixations than the Novice group.

Testpage D
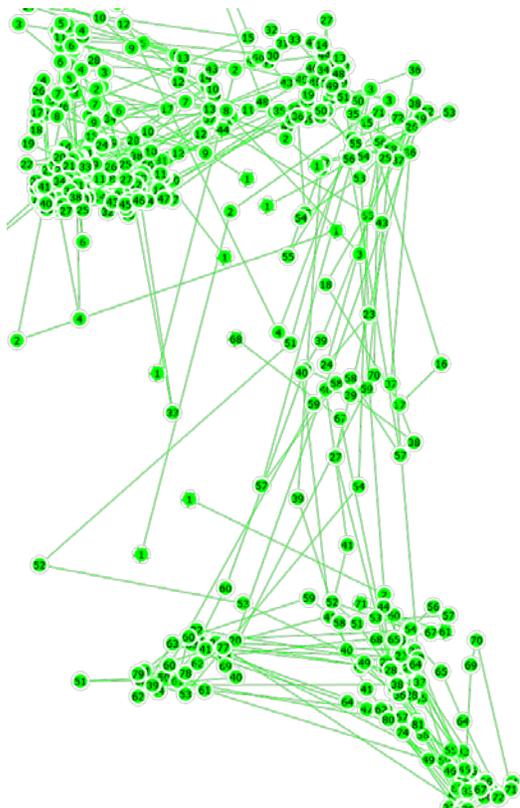


**Figure Y – Nov. scanpath Testpage D     Figure Z – Fam. Scanpath Testpage D**
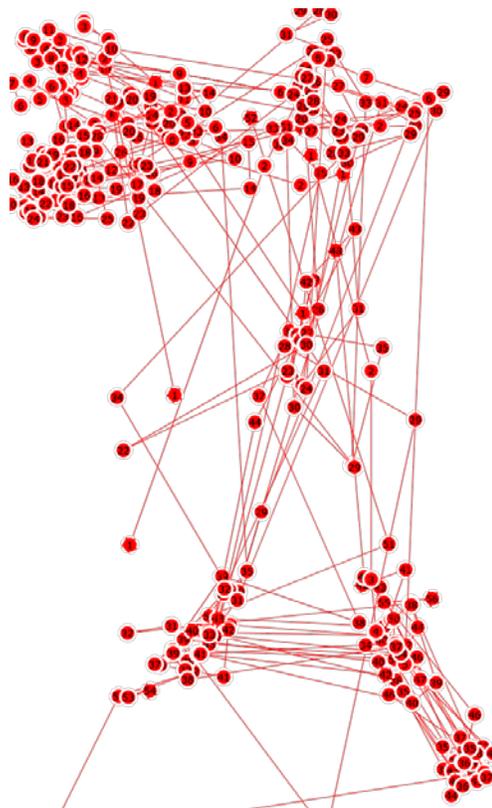
The Novice scanpath again has more lateral movement but the Z pattern is visible in both, particularly in the Familiar scanpaths. The bottom right quadrant of Testpage D – which is where Nova and his crown are situated – is discussed further in the Analysis of Semi-Structured Interviews section further on in this paper. The large looming picture of Archon, who was in the center of this page is also discussed in the interview section, but as can be seen in the middle of Figure Z, it appears it was glimpsed by the Familiars as they moved on the vertical axis.

<u>Visual Analysis by Others</u>

In order to define whether the patterns being seen by myself could also be recognized by others not involved in the research, new scanpaths of the four testpages were generated. These were the same as Figures R through Z above, but colored the same and then printed and assigned a random number using a randomization engine – see Table 3 below. The testpages were paired and four people were told that each page had been viewed by two different groups. They were then asked to divide the pairs into two separate piles based on which of the two groups they believed had created each scanpath (i.e. You have chosen page 3, which of page 2 and 8 do you think was viewed by the same group?). Of the four intercoders, two perfectly matched the groups together while the other two both mixed Testpage D (i.e. placed the Familiar scanpath with the Novice group). Table 4 shows how each intercoder grouped the scanpaths. The two intercoders who matched all pairs correctly said that they had grouped the first set – which was the Familiar group – together "because it seemed more focused, there seemed to be less noise [lateral movement]" and that the fixations were more tightly clumped together. One said that the "[The Novice scanpaths] had a wider spread". The two intercoders who switched Testpage D – the Z-path – expressed similar sentiments. These results strengthen the validity of the visual analysis above.

**Table 3.**

| Group/Testpage | Random Number |
|---|---|
| *Familiar A* | *3* |
| *Familiar B* | *2* |
| *Familiar C* | *7* |
| *Familiar D* | *4* |
| Novice A | 6 |
| Novice B | 8 |
| Novice C | 1 |
| Novice D | 5 |

**Table 4.**

| Intercoder | Group A | Group B |
|---|---|---|
| 1 | *3275* | 8164 |
| 2 | *3275* | 8164 |
| 3 | *3274* | 8165 |
| 4 | *3274* | 8165 |

## Analysis of Order of AOIs

Without access to Parallel Scanpath Analysis software, I was required to generate my own method of analyzing participant's individual scanpaths of the four testpages. During the semi-structured interviews, the participants discussed that they used the text bubbles as 'road signs' which had been expected due to prior research from Cao, Lau, & Chan (2014). As stated in the Methodology section, the text bubbles on the Testpages were turned into AOIs for the purpose of analysis and assigned numbers based on their position in the CSP.

To determine each individual participant's journey through the page and to see how closely it followed the page's CSP, I recorded each time a participant visited a particular AOI and in what order, looking for backtracking or 'jumping' around the page. As discussed in the Methodology section, some 'eyeballing' had to take place to determine where the participant had intended to look due to calibration errors and the granularity of results required (See Figure J above). At this point, the AOIs were adjusted to allow overlap as the visitation counts were calculated by hand rather than

being automatically generated.  Overlapping AOIs can lead to double-counting visitations

and skewed results when carried out by software alone.



**Figure AA – AOIs of Testpage A.**
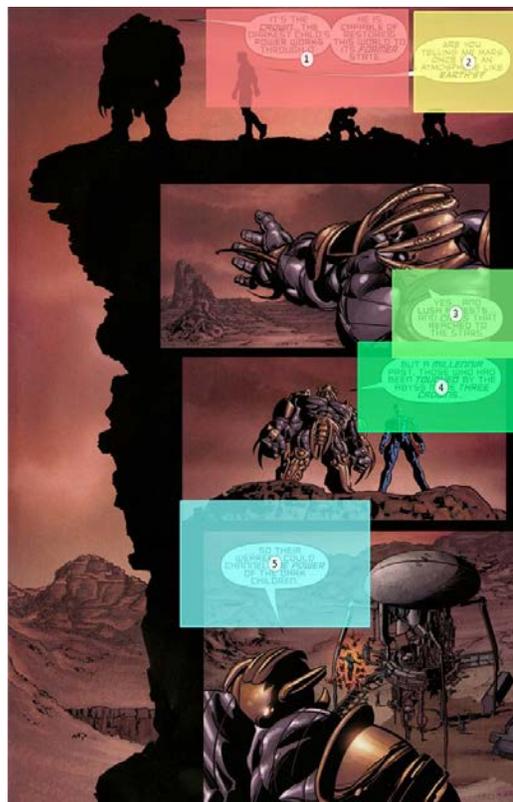
**Figure AB – AOIs of Testpage B.**

**Figure AC– AOIs of Testpage C.**　　**Figure AD – AOIs of Testpage D.**

I did not look at what might draw the participants eye away from the AOI.
During the interview portion of the test, participants discussed looking away from the text
to see the faces of those speaking but then returning to the text.  Based on this self-
proclaimed process, I decided to explore the difference in the ability of the two groups to
return to the text and move on to the next AOI in the CSP.

<u>Visitation Counts</u>

A table was generated to look at the overall visits to AOIs before discussion of the chronology took place (Table 5). As was to be expected by the data shown above, the Novices spent more time on a page and had more fixations than the Familiars and had more visits to the AOIs on Testpages A, C and D – but less on average on Testpage B.

**Table 5.**

| Participant | Testpage | Total Visits | Testpage | Total Visits | Testpage | Total Visits | Testpage | Total Visits |
|---|---|---|---|---|---|---|---|---|
| S1 | a | 30 | b | 6 | c | 12 | d | 15 |
| S2 | a | 10 | b | 5 | c | 5 | d | 5 |
| S3 | a | 11 | b | 5 | c | 9 | d | 12 |
| S4 | a | 24 | b | 10 | c | 7 | d | 10 |
| S6 | a | 23 | b | 8 | c | 8 | d | 6 |
| S8 | a | 17 | b | 6 | c | 9 | d | 11 |
| S9 | a | 15 | b | 9 | c | 11 | d | 11 |
| S10 | a | 12 | b | 5 | c | 8 | d | 8 |
| Summary | a | 17.75 | b | 6.75 | c | 8.63 | d | 9.75 |
| | | | | | | | | |
| Participant | Testpage | Total Visits | Testpage | Total Visits | Testpage | Total Visits | Testpage | Total Visits |
| S7 | a | 12 | b | 6 | c | 6 | d | 12 |
| S11 | a | 8 | b | 8 | c | 6 | d | 6 |
| S12 | a | 21 | b | 6 | c | 7 | d | 9 |
| S13 | a | 7 | b | 5 | c | 6 | d | 6 |
| S14 | a | 10 | b | 11 | c | 6 | d | 8 |
| S17 | a | 10 | b | 6 | c | 5 | d | 5 |
| S18 | a | 12 | b | 7 | c | 8 | d | 7 |
| Summary | a | 11.43 | b | 7.00 | c | 6.29 | d | 7.57 |

While on its own this is surprising, it is in line with the results discussed in the Initial Time and Fixation Analysis section above that showed that the Familiars and Novices were closer in terms of times and fixations on Testpage B than on any other page. This also highlights the limitations of this study of having so few participants. Only two fewer total visits by the Familiar group on AOIs on Testpage B would have reversed this result

<u>Chronology</u>

The four tables below (Tables 6 – 9) show the order that each participant visited the particular AOIs, which can be seen above at Figures AC through AF. The shaded cells show where the participant first entered and then completed the chronological sequence path for the first time. This was determined by searching each individual scanpath and finding where they started to move in the correct sequential order. As stated above, the Novices and their results are in plain text, while the Familiars are in *italics.*

Testpage A

**Table 6.**

| S1 | S2 | S3 | S4 | S6 | S8 | S9 | S10 | S7 | S11 | S12 | S13 | S14 | S17 | S18 |
|----|----|----|----|----|----|----|-----|----|-----|-----|-----|-----|-----|-----|
| 1 | 3 | 3 | 3 | 3 | 3 | 3 | 6 | 1 | 1 | 3 | 1 | 3 | 1 | 3 |
| 3 | 1 | 1 | 3 | 4 | 1 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 4 |
| 1 | 2 | 2 | 6 | 4 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 1 |
| 7 | 1 | 3 | 7 | 5 | 4 | 2 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 2 |
| 2 | 3 | 4 | 4 | 1 | 5 | 1 | 1 | 5 | 5 | 1 | 5 | 4 | 3 | 1 |
| 1 | 4 | 5 | 1 | 5 | 6 | 4 | 2 | 2 | 6 | 2 | 6 | 5 | 4 | 3 |
| 5 | 5 | 3 | 2 | 1 | 7 | 3 | 3 | 5 | 7 | 6 | 7 | 6 | 5 | 4 |
| 4 | 5 | 5 | 2 | 2 | 2 | 5 | 4 | 6 | 7 | 3 |   | 6 | 6 | 5 |
| 3 | 6 | 6 | 6 | 7 | 1 | 5 | 5 | 7 |   | 1 |   | 7 | 7 | 5 |
| 4 | 7 | 7 | 3 | 7 | 2 | 6 | 6 | 6 |   | 2 |   | 7 |   | 6 |
| 7 |   | 7 | 4 | 6 | 7 | 7 | 7 | 2 |   | 3 |   |   |   | 7 |
| 1 |   |   | 6 | 5 | 4 | 6 | 7 | 5 |   | 3 |   |   |   | 2 |
| 2 |   |   | 7 | 4 | 1 | 1 |   |   |   | 1 |   |   |   |   |
| 6 |   |   | 3 | 5 | 2 | 2 |   |   |   | 3 |   |   |   |   |
| 2 |   |   | 3 | 1 | 1 | 1 |   |   |   | 4 |   |   |   |   |
| 1 |   |   | 1 | 4 | 6 |   |   |   |   | 5 |   |   |   |   |
| 3 |   |   | 2 | 5 | 5 |   |   |   |   | 5 |   |   |   |   |
| 4 |   |   | 3 | 6 |   |   |   |   |   | 6 |   |   |   |   |
| 7 |   |   | 4 | 7 |   |   |   |   |   | 7 |   |   |   |   |
| 3 |   |   | 5 | 7 |   |   |   |   |   | 7 |   |   |   |   |
| 4 |   |   | 6 | 1 |   |   |   |   |   |   |   |   |   |   |
| 5 |   |   | 7 | 2 |   |   |   |   |   |   |   |   |   |   |
| 6 |   |   | 2 | 7 |   |   |   |   |   |   |   |   |   |   |
| 5 |   |   | 1 |   |   |   |   |   |   |   |   |   |   |   |
| 7 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

As can be seen in the table above the Familiars entered Testpage A's CSP earlier while the Novices were more likely to revisit Areas of Interest after completing the CSP. On Testpage A Subjects 1 and 6 never recorded a correct CSP. S8 initially skipped AOI2

completely, before eventually finding it after already 'completing' the page (i.e. reading

AOI 3 through AOI 7 in order). I believe these actions by Novices led to the greater

amount of lateral lines discussed earlier in the Initial Visual Analysis section. As stated

previously it can be seen that S12 and S14, both Manga readers, started initially in the top

right corner in AOI 3, before finding AOI 1 and progressing smoothly through the

remainder of the page. Despite this initial confusion, both were able to complete the

CSP.

Testpage B

**Table 7.**

| S1 | S2 | S3 | S4 | S6 | S8 | S9 | S10 | S7 | S11 | S12 | S13 | S14 | S17 | S18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| 3 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 2 |
| 4 | 4 | 4 | 3 | 2 | 4 | 3 | 4 | 3 | 2 | 4 | 4 | 2 | 4 | 3 |
| 5 | 5 | 5 | 3 | 3 | 5 | 4 | 5 | 4 | 3 | 4 | 5 | 3 | 4 | 4 |
| 4 |  |  | 4 | 4 | 5 | 4 |  | 5 | 3 | 5 |  | 4 | 5 | 4 |
|  |  |  | 4 | 5 |  | 4 |  |  | 4 |  |  | 5 |  | 5 |
|  |  |  | 5 | 5 |  | 4 |  |  | 5 |  |  | 5 |  |  |
|  |  |  | 5 |  |  | 5 |  |  |  |  |  | 4 |  |  |
|  |  |  | 1 |  |  |  |  |  |  |  |  | 5 |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |  |

As stated above the Novices had less visits to AOIs than the Familiars but the

novices were still more likely to revisit AOIs after completing the page – four individuals

as compared to one. It can also be seen that apart from S9 and S11 all participants found

AOI 1 very quickly. Of the four AOI 1s across the testpages, Testpage B's was the

highest physically on the page, which could have led to the participants all being able to

identify it quickly.

Testpage C

**Table 8.**

| S1 | S2 | S3 | S4 | S6 | S8 | S9 | S10 | S7 | S11 | S12 | S13 | S14 | S17 | S18 |
|----|----|----|----|----|----|----|-----|----|-----|-----|-----|-----|-----|-----|
| 1 | 1 | 4 | 3 | 3 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
| 2 | 2 | 5 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| 3 | 3 | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 1 |
| 4 | 1 | 1 | 3 | 3 | 4 | 1 | 3 | 4 | 4 | 2 | 3 | 3 | 4 | 2 |
| 5 | 4 | 1 | 4 | 4 | 3 | 2 | 4 | 5 | 5 | 3 | 4 | 4 | 5 | 3 |
| 4 | 5 | 2 | 4 | 5 | 4 | 2 | 5 | 5 | 4 | 4 | 5 | 5 | | 4 |
| 5 | | 3 | 5 | 5 | 5 | 3 | 5 | | | 5 | | | | 5 |
| 3 | | 4 | | 5 | 4 | 3 | 4 | | | | | | | 4 |
| 5 | | 5 | | | 4 | 4 | | | | | | | | |
| 4 | | | | | | 5 | | | | | | | | |
| 3 | | | | | | 5 | | | | | | | | |
| 4 | | | | | | | | | | | | | | |

Again the Novices were more likely to revisit AOIs after completing the CSP. It is also interesting that nearly all of the Familiar's first AOI recorded was AOI 1 – while only three of the Novice group did the same, unlike Testpage B. This could be in support of the ideas stated in the Initial Time and Fixation analysis that the Familiar group were quicker to recognize the 'Shepherd's Crook' design from Testpage B.

Testpage D

**Table 9.**

| S1 | S2 | S3 | S4 | S6 | S8 | S9 | S10 | S7 | S11 | S12 | S13 | S14 | S17 | S18 |
|----|----|----|----|----|----|----|-----|----|-----|-----|-----|-----|-----|-----|
| 1 | 1 | 3 | 3 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 3 | 3 | 1 | 3 |
| 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 1 |
| 2 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 |
| 3 | 4 | 2 | 1 | 3 | 2 | 2 | 3 | 3 | 4 | 1 | 3 | 3 | 4 | 3 |
| 2 | 5 | 3 | 3 | 4 | 2 | 2 | 3 | 2 | 5 | 2 | 4 | 4 | 5 | 4 |
| 1 |  | 3 | 2 | 5 | 3 | 2 | 4 | 3 | 4 | 3 | 5 | 4 |  | 5 |
| 2 |  | 4 | 1 |  | 4 | 3 | 5 | 4 |  | 3 |  | 5 |  | 4 |
| 1 |  | 5 | 3 |  | 4 | 3 | 4 | 3 |  | 4 |  | 4 |  |  |
| 2 |  | 5 | 5 |  | 5 | 3 |  | 4 |  | 5 |  |  |  |  |
| 3 |  | 5 | 4 |  | 4 | 4 |  | 5 |  |  |  |  |  |  |
| 3 |  | 5 |  |  | 3 | 5 |  | 4 |  |  |  |  |  |  |
| 5 |  | 4 |  |  |  |  |  | 4 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

For both the Novice and Familiar groups, as shown above in Table 2, Testpage D had the second highest number of AOI visitations. This could be due to the design on Testpage D – the four inset panels are widely spaced in the four corners of the page. The reader's eye has further to travel before coming to the next AOI – particularly when compared to Testpage B and C whose action and panels were more tightly focused in the top and center of the page. I contend that the Novice traversing across the entire page is more likely to get distracted by another text bubble or element of interest such as a face, whereas the Familiar will be more comfortable to travel a long distance to the place they 'know' is right.

S4 never hit the true chronological path for this page, however in the discussion of this page he recounted that he had gone right to left at the bottom of the page, due to

the bright colors of Nova in the bottom right panel.  S1 did not state this explicitly in their

discussion but this may have also been the case.  Many participants commented on this

panel and why they had looked at it – as can be seen in Figure AE below.
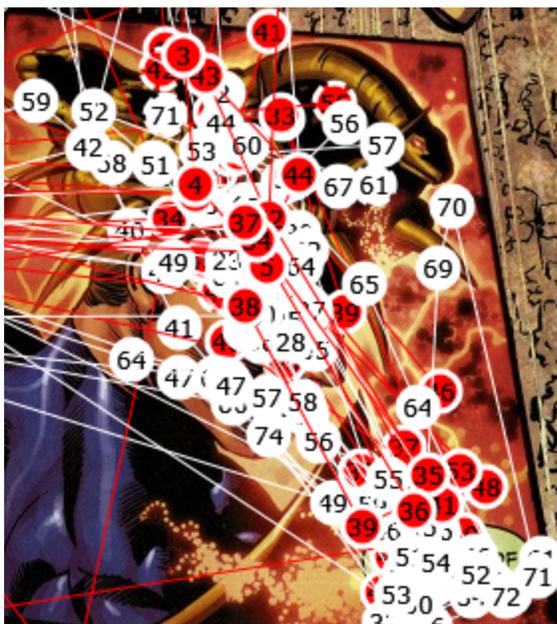


**Figure AE - Combined scanpaths showing participant gaze of Nova's crown.**

S3 commented that "I was pretty fixated on that crown thing because it looked

pretty strange" and S12 remarked that "I stayed here for a second because that's crown

really ugly".  As stated above, S4 reversed their normal Z-path reading style to look at it,

and S11 said that when looking at the page:

> "I think paid special attention to [Nova in his crown] cos of the colors. They're
> really bright and jumped out at me. The reds are a lot brighter, it seems like a lot
> more little details with the little dots and the electricity kind of sparking out the
> crown. I just wanted to go back, it looked cool, I wanted to look at it more."

As can be seen in Figure AE, as well as in Figures Y and Z, a lot of attention was

paid to this panel in particular.  The bright colors and design seem to have drawn the

attention of both the novice and familiar groups here. Having brighter colors appear away from the CSP could lead to participants losing their place in the chronology.

During the interview phase of the study, each participant was shown Testpage D with all participants (except S4) reporting that they had followed the Z-path, supported by Table 6. Most participants also said that they had first been drawn to the Archon in the middle of the page – however viewing the scanpaths and AOI Visitation Tables (Appendix G) it can be seen that very few participants looked at the Archon long enough for a fixation to be recorded before moving into an AOI.

When asked what they used to navigate Testpage D, participants reported that they were following the text; however, S5 and S6 reported they had followed the motion lines. S5's data was removed to calibration errors but S6's data in Table 10 supports this.



**Figure AF – Highlighting the motion lines that lead participant's eyes on Testpage D.**

Analysis of Semi-Structured Interviews

**Table 11.**
Summary of Results

| NOVICES | FAMILIARS |
|---|---|
| Longer time per page | *Shorter time per page* |
| More fixations per page | *Fewer fixations per page* |
| More fixations away from AOIs | *More focused on AOIs* |
| Slower to find the CSP | *Faster to find the CSP* |
| More likely to visit AOIs after completing the CSP | *Less likely to visit AOIs after completing the CSP* |

During the post-testing interview the participants were asked a range of questions that can be seen in Appendix E.

How participants thought they navigated through the page was the primary question behind these interviews. Participants responded that they used the text to follow the story – and will look in the top left, consistent with the Z-path to find it:

"I normally read the words first, especially for graphic novels, because sometimes the panels are not that distinct so I will first find where is the starting point for the page. Normally it's on the top left but sometimes the framing is a little bit weird so some pages have different framing so look for start of page first and then read the words and then if I realize I'm on the wrong side of the page I will quickly shift to the other side" – S14.

A sentiment most respondents agreed with was described by S17 as you have "got to read the words first and then look at the picture. Panel by panel, words pictures, words pictures."

However, the dominant/inset page may not have a panel or text bubble in the top left which lead to some confusion and not just among the Novice participants. S18 said when reading a graphic novel:

> "I usually take in the whole thing and then stop myself, because I'm realize I'm going to get spoiled, so I read the text at the top, and look at the pictures and then look at the next text over to the right and then look at the pictures and go left to right, top to bottom then maybe look at pictures once I've finished the page"

However, she said when reading a dominant/inset page and Testpage D in particular that it is "more confusing, it's hard to know what to concentrate on – I know I'm supposed to concentrate top left first, but this is so big it draws my eye first and then I lost the chronology of the story". Viewing her Testpage D data in real time does show that she was initially lost, however she found the CSP quickly.

S9 said she had been confused by the changes in the foreground and background, which is particularly evident on Testpage A, when she was:

> "trying to figure out if when there are boxes on the page and then there's a different picture in the background if I should focus on the background picture first or the boxes…. I was focusing on the boxes and then going to the background picture in those instances."

The Familiars, who all said they had come across dominant/inset panels before, were on the whole comfortable with navigating them, even S18 who said that when it works properly "it just feels like it flows better". S17 said when coming across these pages "Most of the time [the creators] do pretty well with placing elements so you know where to look first". I believe this shows that familiars as a group either trust that the creators have left them a trail to follow, or are unconsciously following visual and other clues more easily than the novice group – in line with all the other results previously stated. S7, who was more interested in art than text said of the dominant/inset pages that:

"I think it's more interesting when it's less formulaic. Not that formulaic is bad necessarily but it's an interesting way to set up the page, maybe gives you more focus on the art and gives the artist more room for the artist to do interesting things if he has more space".

Novice reader S3 believed that "if you're more accustomed to it, it would be more effective…. I think its fine essentially, nothing inherently wrong with it. It's just different from what I've typically seen. It took me a while to position the layout of where I would be reading."

Additional points that were made in discussion helped to explain some of the individual results. S7 recorded the second highest number of AOI visits for a Familiar and would be the highest if not for S12 having 21 visitations on Testpage A compared to 6, 7 and 9 on Testpages B through D (See Table 2). S7 said she was interested in the story but then "I like to take a minute to look at the art because I like different art styles". This could explain her higher number of AOI visits and fixations.

Individual reading styles obviously play a huge part whenever a study is being done on reading. S14 said when encountering a graphic novel for the first time "it's more of a skimming through and then if I decide it's worth re-reading I will go back and actually focus on things." S3 said when a character was mentioned by name they would attempt to find them on the page – which said lead to her reading being slower – however she was faster and had fewer fixations than the average Novice reader on Testpages A, B and C (Appendix F).

Participants were asked if they could identify any part or element of the page that they believed they may have skipped on the initial viewing. S1 identified the red

emphasis bubble around Archon speaking to Captain America – See Figure AG below -

however no other participant reported seeing anything they had not seen before.



**Figure AG showing a red emphasis bubble around Archon's words.**

Some participants acknowledged that they will skip elements or portions of the

page. S15 said due to the nature of Japanese Manga, which often uses similar or large

character faces, she would frequently skip these faces when reading. S13 said:

> "If there's a big wall of text, then sure (I'll ignore it) but I'm not reading a book, I'm just looking at pictures with a few words."

S11 who was another frequent Manga reader said that:

> "If the image seems pretty straightforward then I won't go back and look at it for details. I will accept what I see from my peripherals and then move on to the next thing."

Both S9 and S16 said they would skip the written-in sound effects or word art like

'Kapow'.

## LIMITATIONS

A possible limitation to this study and others involving graphic novels is the possibility for distraction. S11 reported that when reading a graphic novel, it was easier for her to be distracted and removed from the story – possibly because of the multi-modal nature of the text. With this in mind, future studies should take place with an actual graphic novel rather than a computer screen and should, if possible be in a more natural surrounding rather than an unfamiliar lab space. Another limitation is that I found two distinct groups within the familiar group: Familiar Western Readers and Familiar Manga Readers. However, there were not enough participants to disaggregate the familiar group. I recommend that next time the study be designed for a sufficient number of participants to analyze all three groups. Limitations also existed on the number of participants and calibration errors. As stated earlier in future research having specifically designed testpages with wider gaps between AOIs would be beneficial to prevent overlap and having more participants would allow for the removal of participant data with poor calibration.

## CONCLUSION

As has been shown in traditional graphic grid-based graphic novels, novice and familiar readers will read in different ways. Familiar readers are thought to read smoother, with the ability to skip elements and still retain comprehension of the story.

The new dominant/inset style page had not been examined under eye tracking conditions which led to the creation of this exploratory research study. Through eye tracking of four dominant/inset graphic novel pages and analyzing the results using visual analysis I have found that:

1. Novice readers take longer to read the page and will have more fixations.

2. They will visit and revisit text bubbles more than a familiar reader.

3. They will not be as smooth in following the CSP laid out by the author-illustrators.

4. Despite some difficulty in navigation it appears that readers appreciate the break from the traditional grid pattern of graphic novels.

When designing dominant/inset pages creators should remember that by placing text in the top right corner, there is a risk that even Familiar readers of graphic novels could be thrown off of the CSP and brighter colors could draw the eye again away from the path.

Future research could focus on several questions raised from this study. These include questions as to whether there is a discernible difference between familiar readers of Western style comics and graphic novels and readers who are more familiar

with Japanese style Manga.  Researchers could also examine whether Novice or Familiar

readers recognize an altered page with non-essential elements either removed or added as

this would test both their recall and initial readings.

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# APPENDIX A

Recruitment Script for seminar class.


"Hi Everyone,

My name is Mark Riddle and I am a second year MSLS student here in SILS. As part of my Master's Thesis I am undertaking a research study of how individual's read graphic novels and I am looking for potential subjects for my study. Professor Andrews has kindly allowed me to speak to you today.

Taking part or not taking part in the study HAS ABSOLUTELY NO EFFECT on your grade for this class.

The study will include reading a graphic novel using the Tobii Pro X2-30 Eye Tracker downstairs in the Eye Tracking Suite followed by a short interview. The study should take no longer than an hour per participant and subjects will receive $15 at completion of the interview. Subjects who are both familiar and unfamiliar with graphic novels are required. Subjects must be aged 18 years or older.

As you leave the classroom, you will see flyers on the walls and doors as you go down the staircases. If you are interested in this study, please take one of the tear-off bits with my email address, and contact me to set up a session or email me at mark23@live.unc.edu for more information – mark23@live.unc.edu.

Once again: taking part or not taking part in the study HAS ABSOLUTELY NO EFFECT on your grade for this class.

Thankyou for your time."

## APPENDIX B

Recruitment Flyer

# Eye-Tracking Study of Graphic Novels

## PARTICIPANTS NEEDED

The research study will include reading a graphic novel using a commercially available Tobii Pro X2-30 Eye Tracker on campus in Manning Hall. This will be followed by a short semi-structured and recorded interview. The study should take no longer than an hour per participant and subjects will receive $15 at completion of the interview. Subjects who are both **familiar** and **unfamiliar** with graphic novels are required. Subjects must be aged 18 years or older.

Contact mark23@live.unc.edu for more information and please indicate how often you read graphic novels in the initial email.

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**APPENDIX C**

Cover of Secret Avengers: Mission to Mars – used to introduce characters to participants.

## APPENDIX D

Plot synopsis used to familiarize participants with the storyline.

"Captain America and his team of Secret Avengers have gone on a Mission to Mars. Whilst there, one member, Nova, has found and placed on his head a crown which seems to have taken him over.  The other Avengers have uncovered a creature – An Archon, a large purple and gold character, who wants to help them stop Nova."

# APPENDIX E

Semi-structured interview guiding questions.

Guiding questions:
What is your preferred graphic novel style: Western style or Japanese Manga?
Please elaborate on your reading style when reading a graphic novel:
Are you more interested in the pictures or the text?
Why?
Are there areas, sectors or elements of the page that you find disinteresting or that you ignored?

So on this particular page where do you think your eyes were drawn to first?
Is there any spot that you think you did not look at on your initial viewing of this page and if so identify that area?
Can you tell me what order you think you looked over this page?
Have you encountered this particular style of graphic novel page before?
What are your thoughts on this particular style of layout?

# APPENDIX F

Time and fixations per testpage.

<u>Testpage A</u>

| Pt. | Testpage | N/F | Time | Fixations |
|---|---|---|---|---|
| S1 | a | N | 38.258 | 109 |
| S2 | a | N | 19.965 | 43 |
| S3 | a | N | 24.4 | 71 |
| S4 | a | N | 39.869 | 119 |
| S5 | a | N | 30.253 | 98 |
| S6 | a | N | 38.864 | 122 |
| S8 | a | N | 32.746 | 81 |
| S9 | a | N | 44.655 | 117 |
| S10 | a | N | 21.696 | 62 |
| Nov. Ave. | | | **32.30067** | **91.33333** |
| *S7* | *a* | *F* | *23.152* | *65* |
| *S11* | *a* | *F* | *27.92* | *55* |
| *S12* | *a* | *F* | *37.655* | *124* |
| *S13* | *a* | *F* | *22.865* | *46* |
| *S14* | *a* | *F* | *28.447* | *82* |
| *S17* | *a* | *F* | *20.317* | *67* |
| *S18* | *a* | *F* | *25.67* | *56* |
| *Fam. Ave.* | | | ***26.57514*** | ***70.71429*** |

Testpage B

| Pt. | Testpage | N/F | Time | Fixations |
|-----|----------|-----|------|-----------|
| S1 | b | N | 24.492 | 66 |
| S2 | b | N | 17.439 | 57 |
| S3 | b | N | 21.184 | 75 |
| S4 | b | N | 30.896 | 91 |
| S5 | b | N | 36.274 | 121 |
| S6 | b | N | 27.623 | 90 |
| S8 | b | N | 36.314 | 90 |
| S9 | b | N | 32.209 | 83 |
| S10 | b | N | 20.25 | 67 |
| Nov. Ave. | | | **27.409** | **82.22222** |
| *S7* | *b* | *F* | *18.99* | *53* |
| *S11* | *b* | *F* | *25.755* | *75* |
| *S12* | *b* | *F* | *34.922* | *103* |
| *S13* | *b* | *F* | *18.655* | *48* |
| *S14* | *b* | *F* | *30.201* | *86* |
| *S17* | *b* | *F* | *18.642* | *68* |
| *S18* | *b* | *F* | *23.353* | *60* |
| *Fam. Ave.* | | | ***24.35971*** | ***70.42857*** |

Testpage C

| Pt. | Testpage | N/F | Time | Fixations |
|-----|----------|-----|------|-----------|
| S1 | c | N | 36.616 | 109 |
| S2 | c | N | 16.46 | 56 |
| S3 | c | N | 23.598 | 83 |
| S4 | c | N | 30.656 | 81 |
| S5 | c | N | 27.741 | 71 |
| S6 | c | N | 35.043 | 98 |
| S8 | c | N | 38.657 | 100 |
| S9 | c | N | 35.626 | 101 |
| S10 | c | N | 20.935 | 67 |
| Nov. Ave. | | | **29.48133** | **85.11111** |
| *S7* | *c* | *F* | *19.403* | *43* |
| *S11* | *c* | *F* | *25.703* | *73* |
| *S12* | *c* | *F* | *27.393* | *80* |
| *S13* | *c* | *F* | *16.359* | *49* |
| *S14* | *c* | *F* | *27.118* | *83* |
| *S17* | *c* | *F* | *18.099* | *64* |
| *S18* | *c* | *F* | *23.1* | *61* |
| *Fam. Ave.* | | | ***22.45357*** | ***64.71429*** |

Testpage D

| Pt. | Testpage | N/F | Time | Fixations |
|---|---|---|---|---|
| S1 | d | N | 21.093 | 59 |
| S2 | d | N | 12.243 | 28 |
| S3 | d | N | 22.49 | 81 |
| S4 | d | N | 22.769 | 68 |
| S5 | d | N | 18.12 | 56 |
| S6 | d | N | 21.121 | 61 |
| S8 | d | N | 23.592 | 73 |
| S9 | d | N | 26.492 | 71 |
| S10 | d | N | 13.848 | 44 |
| Nov. Ave. | | | **20.19644** | **60.11111** |
| *S7* | *d* | *F* | *17.489* | *52* |
| *S11* | *d* | *F* | *16.02* | *42* |
| *S12* | *d* | *F* | *21.875* | *48* |
| *S13* | *d* | *F* | *13.814* | *42* |
| *S14* | *d* | *F* | *18.178* | *54* |
| *S17* | *d* | *F* | *16.381* | *56* |
| *S18* | *d* | *F* | *16.473* | *40* |
| *Fam. Ave.* | | | ***17.17571*** | ***47.71429*** |

# Appendix G

AOI visits and fixation number per testpage.

| Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | a | 1 | 4 | S1 | d | 1 | 2 | S3 | a | 3 | 6 | S4 | a | 3 | 8 |
|  | a | 3 | 6 |  | d | 3 | 6 |  | a | 1 | 7 |  |  | 3 | 10 |
|  | a | 1 | 7 |  | d | 2 | 7 |  | a | 2 | 20 |  |  | 6 | 15 |
|  | a | 7 | 10 |  | d | 3 | 10 |  | a | 3 | 24 |  |  | 7 | 16 |
|  | a | 2 | 13 |  | d | 2 | 11 |  | a | 4 | 26 |  |  | 4 | 18 |
|  | a | 1 | 16 |  | d | 1 | 16 |  | a | 5 | 32 |  |  | 1 | 20 |
|  | a | 5 | 21 |  | d | 2 | 18 |  | a | 3 | 37 |  |  | 2 | 31 |
|  | a | 4 | 22 |  | d | 1 | 26 |  | a | 5 | 40 |  |  | 2 | 38 |
|  | a | 3 | 23 |  | d | 2 | 27 |  | a | 6 | 51 |  |  | 6 | 39 |
|  | a | 4 | 25 |  | d | 3 | 34 |  | a | 7 | 57 |  |  | 3 | 41 |
|  | a | 7 | 29 |  | d | 3 | 38 |  | a | 7 | 62 |  |  | 4 | 43 |
|  | a | 1 | 30 |  | d | 5 | 42 |  |  |  |  |  |  | 6 | 44 |
|  | a | 2 | 38 |  | d | 3 | 49 |  | b | 1 | 2 |  |  | 7 | 45 |
|  | a | 6 | 41 |  | d | 4 | 50 |  | b | 2 | 27 |  |  | 3 | 49 |
|  | a | 2 | 44 |  | d | 3 | 56 |  | b | 3 | 34 |  |  | 3 | 53 |
|  | a | 1 | 45 |  |  |  |  |  | b | 4 | 48 |  |  | 1 | 54 |
|  | a | 3 | 46 | S2 | a | 3 | 3 |  | b | 5 | 63 |  |  | 2 | 56 |
|  | a | 4 | 47 |  | a | 1 | 4 |  |  |  |  |  |  | 3 | 59 |
|  | a | 7 | 49 |  | a | 2 | 10 |  | c | 4 | 3 |  |  | 4 | 61 |
|  | a | 3 | 54 |  | a | 1 | 13 |  | c | 5 | 4 |  |  | 5 | 67 |
|  | a | 4 | 55 |  | a | 3 | 15 |  | c | 1 | 6 |  |  | 6 | 73 |
|  | a | 5 | 59 |  | a | 4 | 17 |  | c | 1 | 11 |  |  | 7 | 89 |
|  | a | 6 | 71 |  | a | 5 | 24 |  | c | 1 | 14 |  |  | 2 | 118 |
|  | a | 5 | 73 |  | a | 5 | 31 |  | c | 2 | 39 |  |  | 1 | 119 |
|  | a | 7 | 78 |  | a | 6 | 35 |  | c | 3 | 42 |  |  |  |  |
|  | a | 6 | 81 |  | a | 7 | 37 |  | c | 4 | 46 |  | b | 1 | 4 |
|  | a | 7 | 83 |  |  |  |  |  | c | 5 | 70 |  |  | 2 | 15 |
|  | a | 2 | 93 |  | b | 1 | 3 |  |  |  |  |  |  | 2 | 22 |
|  | a | 2 | 98 |  | b | 2 | 18 |  | d | 3 | 1 |  |  | 3 | 25 |
|  | a | 1 | 99 |  | b | 3 | 29 |  | d | 1 | 4 |  |  | 3 | 27 |
|  |  |  |  |  | b | 4 | 36 |  | d | 2 | 8 |  |  | 4 | 33 |
|  | b | 1 | 2 |  | b | 5 | 50 |  | d | 2 | 10 |  |  | 4 | 36 |
|  | b | 2 | 24 |  |  |  |  |  | d | 3 | 48 |  |  | 5 | 50 |
|  | b | 3 | 29 |  | c | 1 | 3 |  | d | 3 | 54 |  |  | 5 | 67 |
|  | b | 4 | 37 |  | c | 2 | 19 |  | d | 4 | 60 |  |  | 1 | 89 |
|  | b | 5 | 48 |  | c | 3 | 20 |  | d | 5 | 63 |  |  |  |  |
|  | b | 4 | 59 |  | c | 1 | 24 |  | d | 5 | 66 |  | c | 3 | 2 |
|  |  |  |  |  | c | 4 | 25 |  | d | 5 | 71 |  |  | 1 | 6 |
|  | c | 1 | 2 |  | c | 5 | 42 |  | d | 5 | 76 |  |  | 2 | 15 |
|  | c | 2 | 31 |  |  |  |  |  | d | 4 | 77 |  |  | 3 | 21 |
|  | c | 3 | 46 |  | d | 1 | 3 |  |  |  |  |  |  | 4 | 29 |
|  | c | 4 | 53 |  | d | 2 | 8 |  |  |  |  |  |  | 4 | 37 |
|  | c | 5 | 70 |  | d | 3 | 13 |  |  |  |  |  |  | 5 | 50 |
|  | c | 4 | 71 |  | d | 4 | 20 |  |  |  |  |  |  |  |  |
|  | c | 5 | 72 |  | d | 5 | 26 |  |  |  |  |  | d | 3 | 2 |
|  | c | 3 | 80 |  | d | 5 | 36 |  |  |  |  |  |  | 1 | 6 |
|  | c | 5 | 90 |  | d | 4 | 41 |  |  |  |  |  |  | 1 | 10 |
|  | c | 4 | 102 |  |  |  |  |  |  |  |  |  |  | 1 | 14 |
|  | c | 3 | 104 |  |  |  |  |  |  |  |  |  |  | 3 | 15 |
|  | c | 4 | 105 |  |  |  |  |  |  |  |  |  |  | 2 | 16 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 28 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 | 30 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 5 | 44 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 | 60 |

AOI visits and fixation number per testpage.

| Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S6 | a | 3 | 4 | S8 | a | 3 | 4 | S9 | a | 3 | 4 | S10 | a | 6 | 2 |
| | a | 4 | 5 | | a | 1 | 6 | | a | 3 | 10 | | a | 3 | 4 |
| | a | 4 | 7 | | a | 3 | 9 | | a | 1 | 16 | | a | 1 | 5 |
| | a | 5 | 20 | | a | 4 | 14 | | a | 2 | 17 | | a | 3 | 15 |
| | a | 1 | 21 | | a | 5 | 21 | | a | 1 | 20 | | a | 1 | 18 |
| | a | 5 | 24 | | a | 6 | 32 | | a | 4 | 25 | | a | 2 | 25 |
| | a | 1 | 27 | | a | 7 | 34 | | a | 3 | 37 | | a | 3 | 29 |
| | a | 2 | 43 | | a | 2 | 45 | | a | 5 | 40 | | a | 4 | 32 |
| | a | 7 | 46 | | a | 1 | 47 | | a | 5 | 44 | | a | 5 | 39 |
| | a | 7 | 49 | | a | 2 | 63 | | a | 6 | 61 | | a | 6 | 47 |
| | a | 6 | 50 | | a | 7 | 65 | | a | 7 | 71 | | a | 7 | 51 |
| | a | 5 | 51 | | a | 4 | 70 | | a | 6 | 86 | | a | 7 | 60 |
| | a | 4 | 52 | | a | 1 | 71 | | a | 1 | 91 | | | | |
| | a | 5 | 54 | | a | 2 | 74 | | a | 2 | 105 | | b | 1 | 3 |
| | a | 1 | 56 | | a | 1 | 75 | | a | 1 | 117 | | b | 2 | 16 |
| | a | 4 | 59 | | a | 6 | 78 | | | | | | b | 3 | 28 |
| | a | 5 | 60 | | a | 5 | 81 | | b | 3 | 1 | | b | 4 | 40 |
| | a | 6 | 80 | | | | | | b | 2 | 30 | | b | 5 | 53 |
| | a | 7 | 87 | | b | 1 | 1 | | b | 1 | 39 | | | | |
| | a | 7 | 98 | | b | 2 | 22 | | b | 3 | 43 | | c | 4 | 2 |
| | a | 1 | 104 | | b | 3 | 26 | | b | 4 | 48 | | c | 1 | 3 |
| | a | 2 | 113 | | b | 4 | 37 | | b | 4 | 50 | | c | 2 | 27 |
| | a | 7 | 121 | | b | 5 | 51 | | b | 4 | 53 | | c | 3 | 35 |
| | | | | | b | 5 | 70 | | b | 4 | 73 | | c | 4 | 39 |
| | b | 1 | 4 | | | | | | b | 5 | 74 | | c | 5 | 56 |
| | b | 1 | 21 | | c | 1 | 2 | | | | | | c | 5 | 65 |
| | b | 2 | 27 | | c | 2 | 33 | | c | 4 | 1 | | c | 4 | 67 |
| | b | 2 | 34 | | c | 3 | 35 | | c | 1 | 2 | | | | |
| | b | 3 | 47 | | c | 4 | 40 | | c | 1 | 19 | | d | 3 | 1 |
| | b | 4 | 57 | | c | 3 | 41 | | c | 1 | 22 | | d | 1 | 3 |
| | b | 5 | 66 | | c | 4 | 42 | | c | 2 | 41 | | d | 2 | 9 |
| | b | 5 | 83 | | c | 5 | 72 | | c | 2 | 43 | | d | 3 | 19 |
| | | | | | c | 4 | 95 | | c | 3 | 50 | | d | 3 | 25 |
| | c | 3 | 3 | | c | 4 | 100 | | c | 3 | 65 | | d | 4 | 29 |
| | c | 1 | 4 | | | | | | c | 4 | 67 | | d | 5 | 31 |
| | c | 2 | 38 | | d | 1 | 3 | | c | 5 | 90 | | d | 4 | 39 |
| | c | 3 | 46 | | d | 1 | 6 | | c | 5 | 98 | | | | |
| | c | 4 | 54 | | d | 2 | 10 | | | | | | | | |
| | c | 5 | 81 | | d | 2 | 12 | | d | 1 | 3 | | | | |
| | c | 5 | 89 | | d | 2 | 27 | | d | 1 | 7 | | | | |
| | c | 5 | 95 | | d | 3 | 35 | | d | 1 | 11 | | | | |
| | | | | | d | 4 | 53 | | d | 2 | 15 | | | | |
| | d | 1 | 6 | | d | 4 | 58 | | d | 2 | 34 | | | | |
| | d | 1 | 8 | | d | 5 | 59 | | d | 2 | 38 | | | | |
| | d | 2 | 13 | | d | 4 | 68 | | d | 3 | 40 | | | | |
| | d | 3 | 26 | | d | 3 | 70 | | d | 3 | 44 | | | | |
| | d | 4 | 43 | | | | | | d | 3 | 56 | | | | |
| | d | 5 | 49 | | | | | | d | 4 | 60 | | | | |
| | | | | | | | | | d | 5 | 65 | | | | |

AOI visits and fixation number per testpage.

| Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S7 | a | 1 | 4 | S11 | a | 1 | 4 | S12 | a | 3 | 2 | S13 | a | 1 | 3 |
| | a | 2 | 12 | | a | 2 | 14 | | a | 1 | 4 | | a | 2 | 14 |
| | a | 3 | 21 | | a | 3 | 19 | | a | 3 | 5 | | a | 3 | 21 |
| | a | 4 | 22 | | a | 4 | 21 | | a | 4 | 6 | | a | 4 | 24 |
| | a | 5 | 23 | | a | 5 | 30 | | a | 1 | 7 | | a | 5 | 28 |
| | a | 2 | 29 | | a | 6 | 39 | | a | 2 | 12 | | a | 6 | 31 |
| | a | 5 | 33 | | a | 7 | 44 | | a | 6 | 15 | | a | 7 | 34 |
| | a | 6 | 42 | | a | 7 | 46 | | a | 3 | 17 | | | | |
| | a | 7 | 43 | | | | | | a | 1 | 19 | | b | 1 | 4 |
| | a | 6 | 51 | | b | 3 | 1 | | a | 2 | 33 | | b | 2 | 12 |
| | a | 2 | 63 | | b | 1 | 2 | | a | 3 | 38 | | b | 3 | 17 |
| | a | 5 | 64 | | b | 1 | 12 | | a | 3 | 41 | | b | 4 | 24 |
| | | | | | b | 2 | 21 | | a | 1 | 48 | | b | 5 | 35 |
| | b | 1 | 3 | | b | 3 | 32 | | a | 3 | 52 | | | | |
| | b | 1 | 17 | | b | 3 | 37 | | a | 4 | 54 | | c | 1 | 3 |
| | b | 2 | 25 | | b | 4 | 43 | | a | 5 | 73 | | c | 1 | 6 |
| | b | 3 | 30 | | b | 5 | 60 | | a | 5 | 96 | | c | 2 | 16 |
| | b | 4 | 41 | | | | | | a | 6 | 97 | | c | 3 | 21 |
| | b | 5 | 48 | | c | 1 | 2 | | a | 7 | 106 | | c | 4 | 22 |
| | | | | | c | 2 | 28 | | a | 7 | 121 | | c | 5 | 46 |
| | c | 1 | 3 | | c | 3 | 34 | | | | | | | | |
| | c | 2 | 22 | | c | 4 | 40 | | b | 1 | 3 | | d | 3 | 3 |
| | c | 3 | 23 | | c | 5 | 60 | | b | 2 | 38 | | d | 1 | 4 |
| | c | 4 | 25 | | c | 4 | 73 | | b | 3 | 48 | | d | 2 | 13 |
| | c | 5 | 35 | | | | | | b | 4 | 61 | | d | 3 | 20 |
| | c | 5 | 39 | | d | 1 | 2 | | b | 4 | 63 | | d | 4 | 31 |
| | | | | | d | 2 | 7 | | b | 5 | 83 | | d | 5 | 35 |
| | d | 3 | 1 | | d | 3 | 25 | | | | | | | | |
| | d | 1 | 3 | | d | 4 | 31 | | c | 1 | 3 | | | | |
| | d | 2 | 11 | | d | 5 | 36 | | c | 1 | 15 | | | | |
| | d | 3 | 14 | | d | 4 | 41 | | c | 2 | 34 | | | | |
| | d | 2 | 17 | | | | | | c | 2 | 38 | | | | |
| | d | 3 | 23 | | | | | | c | 3 | 40 | | | | |
| | d | 4 | 30 | | | | | | c | 4 | 46 | | | | |
| | d | 3 | 31 | | | | | | c | 5 | 72 | | | | |
| | d | 4 | 35 | | | | | | | | | | | | |
| | d | 5 | 39 | | | | | | d | 1 | 3 | | | | |
| | d | 4 | 46 | | | | | | d | 3 | 6 | | | | |
| | d | 4 | 49 | | | | | | d | 1 | 7 | | | | |
| | | | | | | | | | d | 1 | 12 | | | | |
| | | | | | | | | | d | 2 | 13 | | | | |
| | | | | | | | | | d | 3 | 24 | | | | |
| | | | | | | | | | d | 3 | 33 | | | | |
| | | | | | | | | | d | 4 | 35 | | | | |
| | | | | | | | | | d | 5 | 41 | | | | |

AOI visits and fixation number per testpage.

| Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. | Pt. | Testpage | AOI | Fix. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S14 | a | 3 | 2 | S17 | a | 3 | 3 | S18 | a | 3 | 3 | | | | |
| | a | 1 | 4 | | a | 1 | 5 | | a | 4 | 6 | | | | |
| | a | 2 | 24 | | a | 2 | 20 | | a | 1 | 7 | | | | |
| | a | 3 | 29 | | a | 3 | 23 | | a | 2 | 15 | | | | |
| | a | 4 | 30 | | a | 4 | 28 | | a | 1 | 17 | | | | |
| | a | 5 | 42 | | a | 3 | 30 | | a | 3 | 20 | | | | |
| | a | 6 | 54 | | a | 4 | 31 | | a | 4 | 24 | | | | |
| | a | 6 | 67 | | a | 5 | 42 | | a | 5 | 31 | | | | |
| | a | 7 | 71 | | a | 6 | 52 | | a | 5 | 33 | | | | |
| | a | 7 | 74 | | a | 7 | 58 | | a | 6 | 36 | | | | |
| | | | | | | | | | a | 7 | 43 | | | | |
| | b | 1 | 3 | | b | 1 | 2 | | a | 2 | 56 | | | | |
| | b | 2 | 21 | | b | 2 | 27 | | | | | | | | | |
| | b | 3 | 32 | | b | 3 | 35 | | b | 1 | 3 | | | | |
| | b | 2 | 34 | | b | 4 | 42 | | b | 1 | 14 | | | | |
| | b | 3 | 37 | | b | 4 | 51 | | b | 2 | 21 | | | | |
| | b | 4 | 46 | | b | 5 | 60 | | b | 3 | 28 | | | | |
| | b | 5 | 61 | | | | | | | b | 4 | 34 | | | | |
| | b | 5 | 74 | | | | | | | b | 4 | 45 | | | | |
| | b | 4 | 78 | | c | 1 | 4 | | b | 5 | 50 | | | | |
| | b | 5 | 80 | | c | 2 | 33 | | | | | | | | | |
| | b | 1 | 83 | | c | 3 | 34 | | c | 4 | 2 | | | | |
| | | | | | c | 4 | 38 | | c | 1 | 4 | | | | |
| | c | 1 | 1 | | c | 5 | 61 | | c | 1 | 8 | | | | |
| | c | 1 | 44 | | | | | | | c | 2 | 30 | | | | |
| | c | 2 | 45 | | d | 1 | 2 | | c | 3 | 33 | | | | |
| | c | 3 | 48 | | d | 2 | 7 | | c | 4 | 34 | | | | |
| | c | 4 | 51 | | d | 3 | 28 | | c | 5 | 51 | | | | |
| | c | 5 | 78 | | d | 4 | 39 | | c | 4 | 56 | | | | |
| | | | | | d | 5 | 47 | | | | | | | | |
| | d | 3 | 2 | | | | | | d | 3 | 7 | | | | |
| | d | 1 | 4 | | | | | | d | 1 | 11 | | | | |
| | d | 2 | 10 | | | | | | d | 2 | 15 | | | | |
| | d | 3 | 31 | | | | | | d | 3 | 24 | | | | |
| | d | 4 | 36 | | | | | | d | 4 | 32 | | | | |
| | d | 4 | 45 | | | | | | d | 5 | 35 | | | | |
| | d | 5 | 48 | | | | | | d | 4 | 38 | | | | |
| | d | 4 | 51 | | | | | | | | | | | | | |