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Web page visual hierarchy: Examining Faraday's guidelines for entry points

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ABSTRACT

Designers want to avoid creating “flat” visual experiences that do not communicate importance within an interface. Faraday's visual hierarchy model is often employed to predict the deployment of attention within web page interfaces (i.e., provide an importance ranking). However, only limited empirical evidence is available to validate its use. Across two studies, the model's predictive ability to determine entry points, as determined by the initial search phase, was examined. In Study 1, simple web pages were artificially manipulated to offer entry points as predicted by the model. In Study 2, current web pages containing greater complexity were coded for entry points. Across both studies, fixations were recorded while participants viewed the web pages. It was discovered that the model does a poor job predicting entry points. Moreover, it demonstrated a lack of sophistication by mainly selecting entry points on element size alone. It was found that both spatial position and distinctiveness can predict earlier attention engagement. Therefore, any updated visual hierarchy model ought to consider user expectations and visual salience. Critically, designers ought to stop employing this visual hierarchy model as its predictions can be misleading.

It is often the goal of web page designers to create good search experiences. This can be achieved by considering how the user's visual system operates. Classically, interface designers have employed Gestalt principles to offer clear groupings within complex or clutter displays (Arnheim, 1954). This historical psychology framework focuses on recognizing the emergent visual whole arising from web page elements. This whole can provide organization, which guides users during a search, through a complex display. Popular principles include grouping common elements by similar features or by spatial proximity. These have been used successfully to create better search experiences by interface designers. Some researchers even claim that these principles are the key to offering intuitive designs (Rosenholtz, Twarog, Schinkel-Bielefeld, & Wattenberg, 2009). It is critical that users be guided to important elements, or they are likely to be missed.

The formation of visual hierarchy design reflects the nature of attentional deployment within interfaces. Attention is often described as being a spotlight moving linearly through an interface (Fernandez-Duque & Johnson, 2002). This reflects our observations of users' fixations forming scanpaths on displays (Rayner, 1998). Clearly, some web page elements are fixated upon and are more likely to be perceived than others that were never fixated upon. This is our information processing system attempting to operate efficiency within an overwhelming environment. We can only store and process a limited amount of conscious information within our working memory system (Baddeley, 1992). Therefore, our system employs two selection mechanisms. First is the physical restriction, which allows only design elements that are fixated upon to receive high-resolution processing. Second is the cognitive restriction, which allows the further processing of objects that the attentional system has maintained in working memory. These selective mechanisms depend on bottom-up influences, like saliency, to maximize information collection efficiency (Itti, 2005). Understanding the influences that guide attention ought to provide valuable insight into how to create easier-to-search interfaces.

Obviously, design decisions like product layouts can impact search efficiency (Hong, Thong, & Tam, 2005). According to Djamasbi and Hall-Phillips (2014), designers need to avoid “flat” visual experiences, which do not communicate an importance ranking among design elements, because this can lead to poorer user experiences, which could transfer to a brand's perceived

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quality. For instance, a good website design can leave users with a positive impression of a store and its merchandise quality (Oh, Fiorito, Cho, & Hofacker, 2008). To create a good user search experience, interfaces need to be designed to encourage users to start their search near an important element.

According to Bradley (2015), designers can create an interface entry point by having a single element be dominant. For instance, it could be a large picture, which carries the greatest amount of visual weight. Then, users can move through a series of sub-dominant focal points. These points carry lesser dominance but still guide attention. This can be achieved through differences in local color contrast. Finally, the other elements should be subordinate and should not grab attention (i.e., the body of the text can appear to fade into the background). This visual hierarchy proposal represents the interface from most-to the less-important distinction by classifying elements as dominant, sub-dominant, or subordinate. Unfortunately, this proposal is not empirically justified or grounded in the psychological theory. According to Grier, Kortum, and Miller (2007), large images do not appear to dominate attention within web pages.

1. Faraday's web page visual hierarchy guidelines

A wide variety of informal publications, from internet design websites to an electronic book, provide recommendations for how to visually guide users through an interface (Bank, 2016; Bradley, 2015; Cao, 2015; Cao, Zieba, Stryjewski, & Ellis, 2015; Jones, 2011; Soegaard, 2016). One of the more commonly referenced in journal articles (e.g., Djamasbi, Siegel, & Tullis, 2010; Masciocchi & Still, 2013; Stone & Dennis, 2011) is Faraday's (2000) web page visual hierarchy model. It was the first model to account for the deployment of attention with web pages. Faraday coined the term “entry points” to depict the location where users typically start their search within a web page. The model is broken into two stages, each with its guidelines, to help designers identify and rank elements from most to least attention-grabbing. The first stage referred to as “the search phase” guides users to a salient entry point. In this specific order (from most to least influence), users are guided by these features: motion, size, images, color, text style, and position. The second stage referred to as “the scanning phase” is when users start to extract information from nearby elements. This is achieved by following grouping principles and reading conventions. In this work, the focus will remain on the initial search phases of the model. For instance, large elements ought to act as search entry points, given no motion is present. Further, if motion and size are not a factor in the display, then an image ought to draw attention over text. Next, if either color or text style is distinct across the display, they ought to draw attention. Finally, if all else is roughly equal, consider position. Users typically enter near the top-left or the center of a web page.

Grier et al. (2007) performed a series of experiments that focused on Faraday's priority claims. Their first three experiments explored the internal validity of the proposed model outside of a web page context. The final experiment asked participants to search for a web element, while specifically examining position and motion. They found some minimal support that motion attracts initial attention. Interestingly, spatial location was found to better predict initial fixations than any other feature highlighted in the model. They suggest that Faraday's model demonstrated its best performance when participants did not have a specific search task (i.e., when they were free-viewing, or mindlessly surfing the web). Other researchers have also found that spatial location (i.e., position) can predict early user fixations (Still, 2017). According to Buscher, Cutrell, and Morris (2009), when entering a new web page, viewers first perform an information foraging task. This is expressed in an initial top-left search bias. This region is conventionally associated with site recognition information (e.g., logos). This paper extends Grier, Kortum, and Miller's (2007) findings by also considering size, image, color, and text-style within naturalistic web pages.

2. Examining faraday's search phase predictions

Designing web pages to support specific user needs is difficult. Websites are typically used by a wide variety of users who perform a wide variety of tasks. But, interfaces can be designed to nudge users to some areas over others (e.g., for safety or profit). The intent of Faraday's search phase is to determine the entry point and to help redesign a targeted entry point. However, if the search phase fails to predict overt attention, the model's usefulness is questionable. Faraday's research motivation was to translate relevant visual search studies into web design decision making. And, it was an impressive first step. However, the work needs further empirical examination and has a need for a more recent reassessment using contemporary web page designs. Faraday's (2000) model visual rankings were supported by classic psychological finding (e.g., Treisman, 1988; Yarbus, 1967). However, the model's predictions were not justified by eye tracking data. The focus was placed on how to apply the model, through a case study, instead of more experimental validation. According to Grier et al. (2007), motion and spatial location appear to account for fixations, but not large images. A qualitative analysis of fixations heat maps suggests that increasing visual complexity increases fixation variability within visual hierarchy displays (Djamasbi, Sigel, & Tullis, 2011). It is not surprising that motion draws attention (Burke & Hornoff, 2001). Designers employ transient signals to exogenously (i.e., reflexively) capture attention. Unlike the nudge of saliency or convention cues within web pages, exogenous cues (like motion) demand attention (impact attentional control). Employing motion can be a double-edged sword (Rensink, 2002). It can draw attention, but more often than not it can disrupt the ongoing task and can be experienced as unpleasant (Iqbal & Bailey, 2008). This attentional cue is categorically different from the others. Exogenous cues take control from users (Fuller, Park, & Carrasco, 2009), rather than providing implicit guidance. These disruptive cues ought to only be used for alerts. In the context of web page design, it is usually too difficult to determine a user's task goals, making the use of exogenous cue inappropriate. Therefore, this work only explores features that gently guide or nudge users through an element hierarchy.

This approach to visually critiquing web pages has been popular among web designers. But, does it actually predict visual entry points? And, does the model still account for a wide variety of entry points following fifteen years of initial development? Web design has quickly evolved in response to technological advancements (e.g., faster download speeds, larger and higher resolution displays). In the first study, the model's predictions were systematically examined and measured by capturing the deployment of attention (by recording fixations). Simple web pages were developed with only one clear entry point based on Faraday's predictions. Participants will view each web page for 5 s, which is a typical page search time (Chen, Anderson, & Sohn, 2001; Nielsen, 2008). In the second study, it is determined whether Faraday's model can still account for a variety of entry points given dramatic changes in web design. Complex, but conventional web pages were collected from the internet. The impact of visual complexity (Djamasbi, Sigel, & Tullis, 2010) and clutter (Henderson, Chanceaux, & Smith, 2009; Neider & Zelinsky, 2008) on entry points was examined by comparing Study 1 and Study 2 stimuli.

3. Study 1: testing entry predictions

3.1. Method

3.1.1. Participants

Twenty undergraduates (15 Females; 18 Right Handed; 19 English Speaking) participated in this study for course research credit. Their ages ranged from 18 to 37 years old. The experiment lasted less than 15 min.

3.1.2. Stimuli & equipment

A graduate research assistant created fifty web page screenshots using the Square Space online editor at the resolution of 1024×768. All of the web pages appeared contemporary and simplistic. Ten web pages were created for each of the five critical visual features predicted by Faraday's model. Every web page contained different images and text. The size stimuli were created by making the biggest element be either an image or a block of text. Image stimuli only contained a single image surrounded by text. Color stimuli presented a uniquely colored text. Text Style stimuli were created by using a unique font manipulation (e.g., bolded). Position stimuli presented text in either the upper left or upper middle. The stimuli were designed while attempting to avoid competition with elements predicted to have greater influence. For example, while creating image stimuli, the embedded image was not the largest element on the web page. The effort was not perfect, as it is sometimes difficult to classify a unique element (e.g., issues arise about figure-ground separation and emergent grouping) (see Appendix A).

Images were displayed on a 43×24 cm screen and were seen at a viewing distance of 60 cm. The images encompassed the entire screen at a 1024×768-pixel resolution and subtended at approximately $38.8° \times 22.3°$ of visual angle.

Fixations were captured and defined by the Tobii Pro X3-120 system. The system's tracking accuracy was ($M = 0.71°$, $SD = 0.27°$) and it was successfully calibrated for all the participants. Further, Tobii Studio (3.4.6) was used to control the displays.

3.1.3. Procedure

Participants were asked to look at the images "as if they were normally surfing the web." The research assistant asked participants to fixate on each of the nine numbers within a 9-point calibration sequence. This process was repeated to provide a means to record system tracking accuracy. The web page screenshots were presented in random order. Each image was shown for 5 s. Between each trial, participants were shown a fixation cross at the center of the display.

3.1.4. Results

All significance tests used an alpha level of 0.05 and were two-tailed. All the figures' error bars represent 95% confidence intervals.

3.1.4.1. Distance between entry point and first three fixations. The mean distance from the entry point and the first three fixations defined this dependent measure. These fixations were shown to represent less than 1 s of processing (Fischer & Weber, 1993). Distance was measured in number of pixels. The lower the distance, and the closer to zero, the better the Faraday's model's predictions.

A 5 (Image Type: Size, Image, Color, Text Style, Position) repeated-measures ANOVA, with Greenhouse-Geisser corrections, was employed to determine whether model predictive performance varied by image type. The Faraday Model's predicted performance did vary by image type, $F(4, 76) = 316.90$, $p < .001$, $N_p^2 = 0.94$. Bonferroni Post-Hoc comparisons revealed that all of the comparisons were significantly different ($ps < .001$), with the exception of Color and Text Style ($p = .9$) (see Fig. 1). If each entry point equally pulls attention, as suggested by the model, a flat function ought to be expected. However, the data does not reflect a flat function. It appears that certain model features show better predictive performance than others. Interestingly, it appears to be in the opposite order suggested by the model. The model's predictive performance from best to worst: Position ($M = 39.14$, $SD = 11.16$), followed by a tie between Text Style ($M = 81.44$, $SD = 11.90$) and Color ($M = 96.89$, $SD = 17.36$), Image ($M = 172.62$, $SD = 16.22$), and Size ($M = 326.61$, $SD = 60.13$).

3.1.4.2. Portion of stimuli when fixations never entered an area of interest. Three different Area of Interests (AOI) were formed by varying the radius size of circles. Each circle was centered on an entry point and had a radius with either 30, 60, or 90 pixels in size. Thus, each AOI had a diameter of 60, 120, or 180 pixels, respectively. This dependent measure reflects the portion of stimuli when participants never enter a defined AOI size. Therefore, the higher the measure, the worse the Faraday model performs.

A 3 (AOI Size of Radius: 30, 60, 90) x 5 (Image Type: Size, Image, Color, Text Style, Position) repeated measures ANOVA, with Greenhouse-Geisser corrections, was employed, in order to determine whether not entering AOIs of various sizes differed by image type. A significant main effect of AOI Size of Radius ($F(2, 38) = 222.30$, $p < .001$, $N_p^2 = 0.92$) and Image Type ($F(4, 76) = 30.39$, $p < .001$, $N_p^2 = 0.62$) was found. The interaction was also found to be significant, $F(8, 152) = 8.26$, $p < .001$, $N_p^2 = 0.30$. This interaction appeared to be driven by a violation in the clear grouping of Size and Image, Color and Text Style, and Position at AOI Sizes of Radius 30 and 60 (see Fig. 2). The AOI Size of Radius of 90 appears too large, which results in the measurement becoming less sensitive. It appears that Position best accounts for entry points, followed by a Text Style and Color, with the worst performance being associated with Image and Size. Clearly, this dependent measure shows how poorly the Faraday model performed. Considering, the performance at the 60 AOI Size of Radius: Size ($M = 0.65$, $SD = 0.14$) and Image ($M = 0.74$, $SD = 0.18$), Color ($M = 0.46$, $SD = 0.22$) and Text Style ($M = 0.44$, $SD = 0.24$), and Position ($M = 0.26$, $SD = 0.21$). The only image type with good performance was Position, which showed a 74% rate of at least being fixated upon within a 5 s viewing period.

4. Study 2: describing entry & model performance

The Faraday model was used to determine entry points within conventional web pages. Over fifteen years have passed since the development of the model. In this period, the internet has quickly

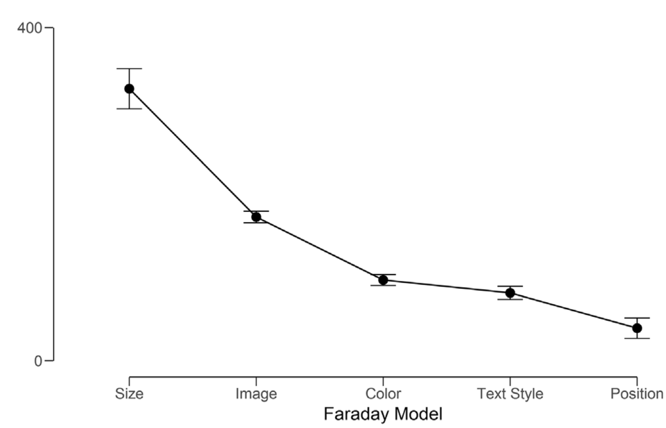


Fig. 1. Mean pixel distance of the first three fixations from the predicted entry points.

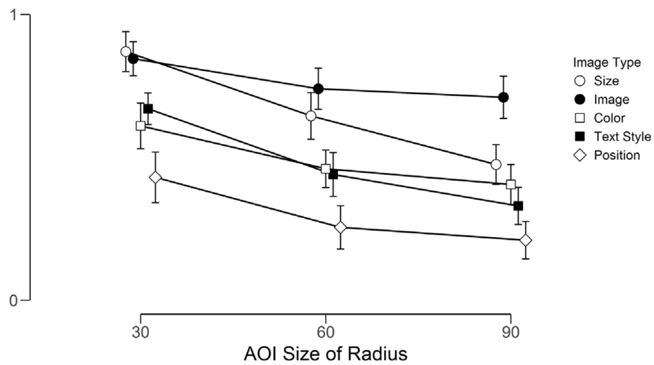


Fig. 2. Mean portion of stimuli when fixations never entered an AOI given size.

adapted and evolved in response to technological advancements. Study 2 examines whether Faraday's model can still account for a variety of entry points given dramatic changes in web design. The predictive performance of the model was examined. Researchers have suggested that clutter influences real-world and artificial scene search efficiency (Henderson et al., 2009; Neider & Zelinsky, 2008). Therefore, Study 1's simpler and artificial stimuli were directly compared with Study 2's complex yet naturalistic stimuli. The following web page stimuli and fixation data are from Still (2017).

4.1. Method

4.1.1. Participants

Twenty-one participants (17 Females; 20 Right Handed; 20 English Speaking) completed Still's (2017) experiment, which lasted approximately 15 min. The eye tracking system was not able to successfully track one participant's eye movements, so those data were excluded from further analyses.

4.1.2. Stimuli & equipment

Still's (2017) experiment had 72 website screenshots that were composed of three types: Mostly text, Mixed images and text, and Mostly images (24 screenshots for each image type). However, the nature scenes also included in the study were ignored. The images were shown full screen at a resolution of 1024×768 pixels and subtended roughly $38.8 \times 22.3°$ of visual angle at a viewing distance of 61 cm. This classification of the images was similar to Masciocchi and Still (2013), with the intention of reflecting the page diversity found in conventional web design. The screenshots were selected using a pseudorandom method. Only homepages appearing beyond a popular search engine's 10th results page and were unfamiliar to the research assistant were captured. The images were presented using the same equipment, viewing sizes, and distances as in Study 1. The system's tracking accuracy was ($M = 0.68°$, $SD = 0.21°$).

These conventional web pages appear to be much more cluttered than those designed in Study 1. Rosenholz, Li, and Nakano (2007)'s computational clutter model was employed to measure the feature congestion difference between Study 1 and Study 2's stimuli. An independent samples T-Test revealed that Study 2 stimuli ($M = 6.74$, $SD = 1.08$) were rated as more cluttered than Study 1 stimuli were ($M = 3.17$, $SD = 0.62$), $t(120) = 21$, $p < .001$, $d = 3.87$.

4.1.3. Procedure

Again, participants were asked to look at the images "as if they were normally surfing the web." They experienced two 9-point calibration sequences. The web page stimuli were presented in random order and were viewed for 5 s. A fixation cross display followed each web page image.

4.1.4. Results

4.1.4.1. Coding entry point types. A research assistant coded web page entry points by following Faraday's predictions. It quickly became apparent that the model predicted entry points mostly based on the element Size. In fact, 94% (68 out of 72 web pages) of the entry points were because of a large picture or a text element. This demonstrates that Faraday's model lacks the sophistication needed to overcome web design heavily dependent on large graphical elements.

4.1.4.2. Distance between entry point and first three fixations between studies. An independent samples T-Test revealed that the Study 1's stimuli ($M = 143.3$, $SD = 15.56$) better predicted entry points than the Study 2's stimuli ($M = 338.4$, $SD = 28.2$), $t(38) = -27.08$, $p < .001$, $d = -8.56$. This decrease in performance is partially due to an increase in visual complexity between the studies.

4.1.4.3. Portion of stimuli when fixations never entered an area of interest. A 3 (AOI Size of Radius: 30, 60, 90) repeated measures ANOVA showed that model performance did vary by AOI Size, $F(2, 38) = 370.20$, $p < .001$, $N_p^2 = 0.95$ (see Fig. 3). Again, to highlight how poorly the model performed, at AOI Size of Radius 60, the model was only able to predict an element that would be fixated upon within a 5-s viewing period 32% of the time (Fig. 4).

Given that most of the stimuli in Study 2 represent the Size image type, Study 1's Size image type was directly compared with Study 2. No significant differences were found between studies, $F(3, 36) = 1.56$, $p = .215$, $N_p^2 = 0.12$. The model's predictive performance continues to be poor (with mean difference scores, respectively, −0.01; −0.04; −0.07).

5. Reflection

According to Faraday (2000), entry points can be predicted during the initial search phase. The model's ability to predict entry points was examined across two studies. In the first study, web pages were specifically designed to reflect clear entry points based on the Faraday's model predictions. It was apparent that even

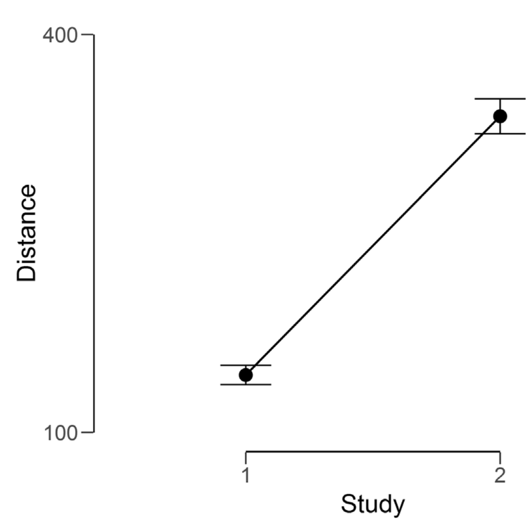


Fig. 3. Mean pixel distance of the first three fixations from the predicted entry points.

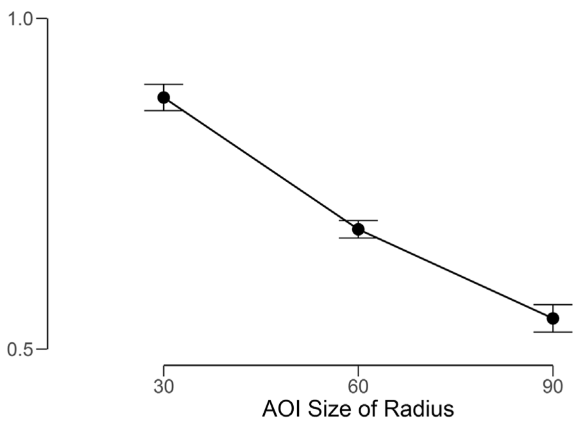


Fig. 4. Mean portion of stimuli when fixations never entered an AOI given size.

under near-perfect conditions, the overall model failed to perform well. However, it was found that Position did a good job of predicting entry points (similar to: Still, 2017) and that both Color and Text style did a fair job. However, Size and Image completely failed to predict (c.f., Grier et al., 2007). Since 2000 the internet has continuously adapted and evolved in response to new technological innovations (e.g., more responsive communications, better design software, changes in digital culture). Study 2 explored whether Faraday's model can still account for a variety of entry points given dramatic changes in web design. Conventional web pages' entry points were determined using the model. It quickly became clear that most web pages have a large element. It appears that only rarely do all of the elements within a web page have a uniform size. Now that larger files can be quickly downloaded large images are ubiquitously employed. This evolution disrupted the model's practical usefulness. It cannot simply be the case that the largest image on almost all pages pulls attention. Beyond the bias towards large images, the behavioral data suggest that the Faraday model overall performed poorly within more recent web pages.

It was discovered that Position was an effective predictor of entry points. As a caveat, these findings reflect a participant sample representing a young college student population composed of skilled internet users. Nevertheless, other researchers have also found that the top-left position of a web page is often attended to (Buscher et al., 2009). Viewers are probably looking there for an information-foraging purpose (e.g., Where am I?). Common web page design guidelines have produced design patterns (Beier & Vaughan, 2003). This consistency across web page experiences has formed schemes within users' long-term memory. The conventional (Still & Dark, 2013) location to find website identity information is on the top-left of the page. These schemes automatically and unconsciously bias experienced users' searches.

It was also found that both Color and Text style did a fair job as an entry point predictor. Elements within a display that are visually distinct appear to influence the attentional selection (Henderson, 2003; Wolfe, 2007). Other researchers have also suggested that element saliency biases visual searches specifically in web pages (Masciocchi & Still, 2013; Shen, Huang, & Zhao, 2015). This salience bias appears to emerge from pre-attentive features being processed in parallel (Treisman & Gelade, 1980). The key variables in determining saliency are contrast (only one unique feature: color or line orientation) and neighborhood similarity. If one word is red on a screen of black text, the determination of saliency is easy. However, as complexity within an interface increases, determining saliency by following a guideline becomes difficult.

It was evident that element Size was not a good predictor of entry points. This is partially a result of the size typically varying continuously within the display. For Size to become salient, the element's size must be distinct from its neighbors (i.e., categorically different). Further, it is often difficult to know whether users will perceive a web element as a unique and separate object within a display. This is the fatal flaw of the image element. Typically, users do not perceive images as web elements. Instead, they merely see an object (like a product) or a collection of objects (teamwork scene). Finally, the model was serially implemented, which limits its usefulness. The resulting fixations are serial, but the cognitive information processing resulting in the fixations is probably rendered in parallel.

5.1. Future work

In an attempt to improve the search phase of a visual hierarchy model, the interaction of two information sources must be considered before an entry point is determined. First the Schemes, which are discovered through recognizing spatial conventions (c.f., Still, 2017). This influence is based on long-term memory. This makes the influence generic (e.g., top-left). It is commonly accepted that familiarity and expectations impact searches (Bacon & Egeth, 1994; Malcolm & Henderson, 2010; Over, Hooge, Vlaskamp, & Erkelens, 2007). Second the Saliency, which is determined by considering contrast (like color, line orientation, etc.) and neighborhood distinctiveness in parallel (c.f., Treisman & Gelade, 1980; Masciocchi & Still, 2013). This influence will reflect the web page properties. It is commonly accepted that Saliency impacts searches (Kim & Cave, 1999; Theeuwes, 1992). These two sources of information are meant to increase search efficiency within overwhelming environments.

Additional work is needed to empirically determine the parameters of these two information sources for effective implementation within web pages. For example, the weighting between Scheme and Saliency needs to be explored (c.f., Still, 2017; Rosenholtz et al., 2009). Also, an operational definition of visual object distinction is needed. Further, it will need to be determined whether designers can reflectively predict entry points or whether a computational model must be employed.

Determining the actual display element a user will fixate is a difficult task given individual differences between users (e.g., web page familiarity). However, it is easier to reframe attentional selection of a design element as a likelihood. A model could generate a probabilistic prediction for each element reflecting its relative saliency ranking. A selection of a single element produces an all or nothing results (i.e., the predictive power will either be good or bad). But, by assigning all the elements with values even if the top entry point is a missed still other information can be gleaned from a model's predictions. Even with an excellent performing model, designers might be resistant if the tool is foreign or not useful to them. Model developments will need to consider the needs of designers. Or, designers might continue using an unreliable introspective process or worst yet miss leading heuristics. Future research needs to not only develop a solution, but make it effective enough to support designers throughout the design and re-design processes.

5.2. Conclusion

According to Djamasbi and Hall-Phillips (2014), designers ought to avoid "flat" visual experiences that do not communicate the importance of interface elements. Visual hierarchy models are often employed to identify an element's ranking within an interface. Faraday's popular web page-specific model was employed to determine entry points and its search phase predictions were examined. It was shown that the model did a poor job predicting early attentional deployment within web pages. Further, Faraday's model demonstrated a lack of sophistication by mostly determining entry points based on element size alone within conventional web pages. Clearly, the findings suggest that both spatial position and distinctiveness can predict earlier attention engagement. Additional empirical research is needed before a solid visual hierarchy model can be offered. It is evident at this point that any new model ought to consider the influences of long-term memory (schemes) and pre-attentive processing (salience) in parallel. Until an updated model is offered, designers ought to stop using Faraday's model as its predictions are misleading.

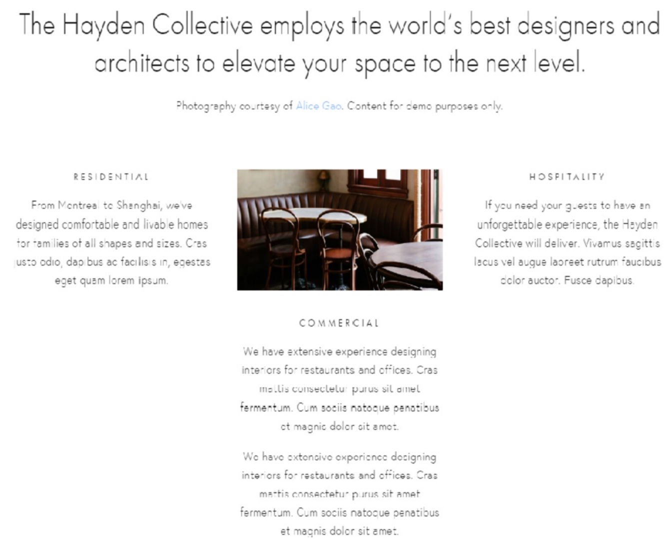
Acknowledgement

Ashley Cain created the stimuli for study one, and helped with data collection as the laboratory supervisor.

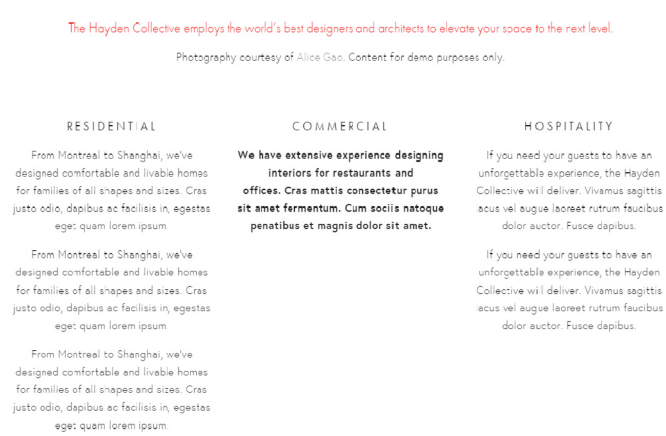
Appendix A. Study 1. Prototypical webpage images for each critical feature type.

A. Size

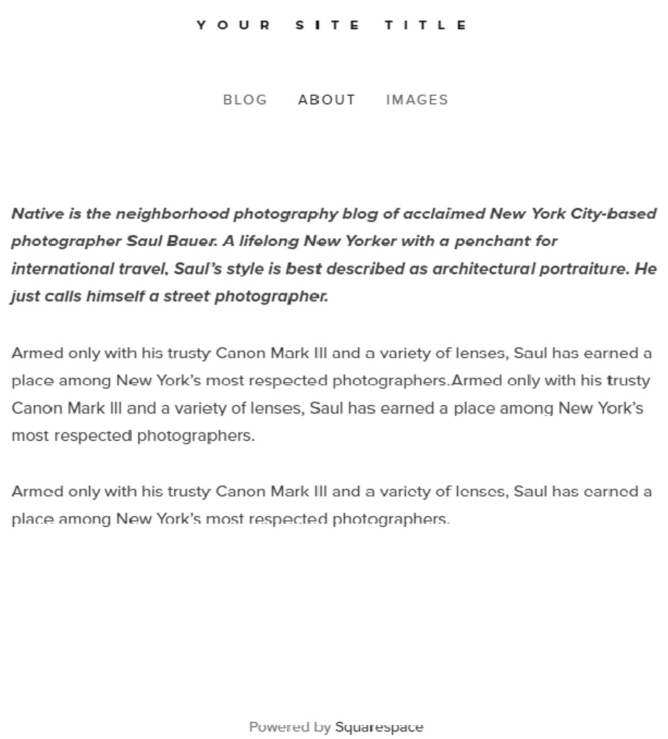
B. Image



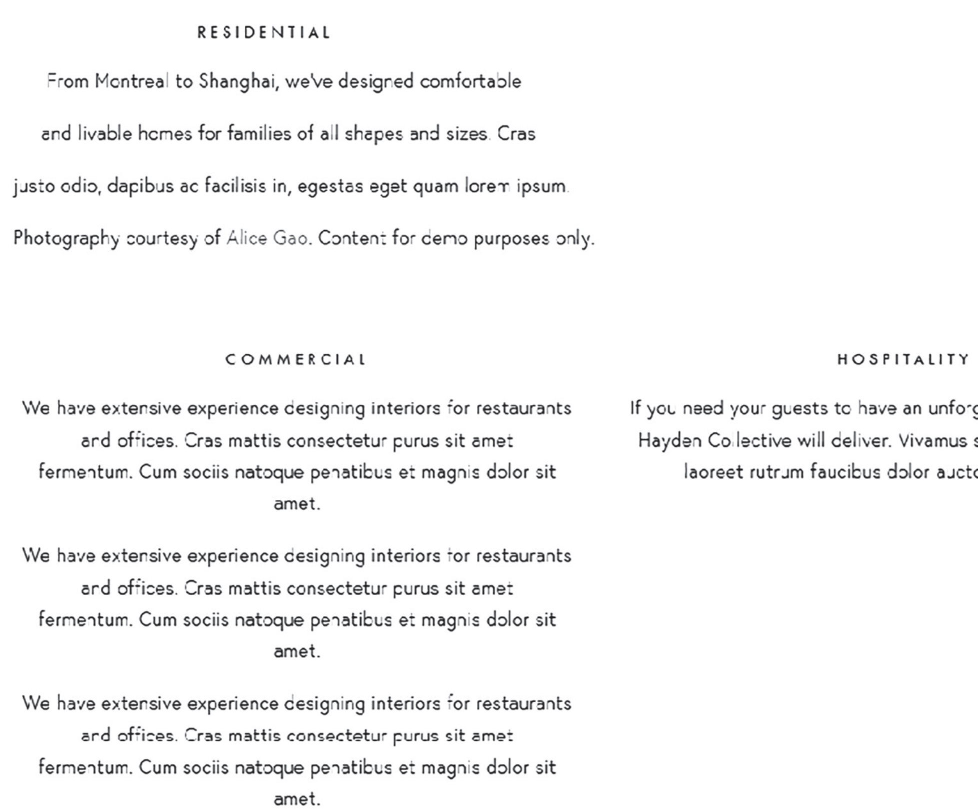
C. Color



D. Text style



E. Position



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