Toward an Understanding of Real Estate Homebuyer Internet Search Behavior: An Application of Ocular Tracking Technology

by

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We track and record five measures of eye movements of current homebuyers who are in the process of searching for homes on the Internet. Total dwell time (how long a person looks at the photo), fixation duration (how long a person spends at each focal point), and saccade amplitude (the average distance between focal points) are all found to significantly explain a buyer's overall opinion of the home and its value. A secondary finding is that the sections of the Webpage that are viewed first are the photo of the home, the quantitative description section, distantly followed by the real estate agent remarks section. Finally, charm pricing, the marketing technique where agents list properties at slightly less than round numbers, works in opposition to its intended effect. Given our result that homebuyers dwell significantly longer on the first home they see, and since charm pricing typically causes a property to appear towards the end of a search when sorted by price from low to high, we question the wisdom of using a charm pricing strategy.

Key words: ocular tracking; behavioral real estate; charm pricing, buyer search behavior.

JEL Classifications: R20; R32; A12

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Introduction

While it is widely recognized that homebuyers rely more and more on the use of the Internet to pre-search for homes[1], very little research has been undertaken to examine *how* people search for homes on the Internet. With the tremendous wealth of information about listed homes online, potential homebuyers must weigh the marginal search cost (time) of looking through thousands of additional properties against the marginal benefit of possibly finding the home that may be slightly better for them[2]. If the number of available homes on the Internet was small, people would spend more time looking at each property. But with so many homes available, it is generally accepted that people spend very little time on a particular property. As such, it is important to understand, through the use of quantifiable data, how homebuyers search the net.

Researchers often refer to the difference between "stated preference" and "revealed preference." A stated preference is what people *say* they prefer or *say* they would do in a certain situation, whereas a revealed preference is what they *actually* do. Even a person who is completely honest might experience a divergence between a stated and a revealed preference as many of our actions occur on a sub-conscious level. Therefore, in order to accurately assess homebuyer preferences, it is important to focus on physiological measures that go beyond simple verbalizations from the user. The purpose of this study is to quantify previously unknown data and thereby advance the field of residential real estate brokerage. Specifically, we use ocular tracking technology to record the exact scanning pattern employed by the homebuyer when searching on the web, the number of locations on the screen where they fixate, and the time spent

[1] See Benjamin, et al. (2005) and Bond, et al. (2000) for the homebuyer market as well as Hagen and Hansen (2010) for the rental market.
[2] See Gwin (2004).

on each fixation point, which serve as indicators of homebuyer (revealed) preferences during the home search process.

Most behavioral experiments use a convenience sample of student participants. This study makes an additional contribution in that we sample from both students and actual homebuyers currently searching for a primary residence. A comparison of our sub-sample results provides a direct test of the extent to which substitution should be deemed acceptable in behavioral experiments between convenient and actual subject samples. We find that our results vary in several key areas and that when possible, subject sample data should be directly collected.

In examining the sequence of each component of the Webpage that is viewed, we find that the photo is overwhelmingly viewed first, followed by the property description section, and lastly, the real estate agent open remarks section. Actual homebuyers pay somewhat more attention to these later two sections when viewing the opening page of the home tour than do students. We suspect this is because students are not actually in the market to buy a home.

Finally, we contribute to the literature on charm pricing, the marketing technique where agents do not round off the listing price to the nearest $1,000 or even $10,000. Instead, prices are listed at slightly lower than round numbers (e.g., $299,900 versus $300,000). Rationally, this $100 should have almost no impact on the homebuyer's opinion of value, yet Allen and Dare (2004) have shown it to be an effective pricing strategy. In opposition to Allen and Dare (2004), our results support the findings of Palmon, Smith, and Sopranzetti (2004) that charm pricing works against the seller. When coupled with our result that homebuyers spend the greatest

amount of time looking at the first home that results from their search, our findings do not support the use of charm pricing strategies[3].

Literature Review

Eye movements are arguably the most frequent of all human movements. Large scanning movements called saccades typically occur 3-4 times every second; the search pattern followed by the eyes as they saccade from one point to another is called the scanpath; and, the amount of time spent at each point is the fixation time. Eye tracking as a methodology is based on Just and Carpenter's (1976) "eye-mind" hypothesis: the location of a person's gaze directly corresponds to the most immediate thought in a person's mind. In usability testing and advertising, eye tracking is useful because it can be used to measure behavior that would be difficult to obtain through other more overt measures (Karn, Ellis, and Juliano, 2000). Due to their close relation to attentional mechanisms, saccades can provide insight into cognitive processes such as picture comprehension, memory, mental imagery and decision-making. Thus, eye movement research has historically been of great interest in the fields of neuroscience and psychiatry, as well as ergonomics, advertising and industrial design.

Eye tracking research that is most relevant to the purpose of our study has been found in the following areas: (1) reading print and online material, and (2) searching and scanning Webpages. Eye tracking studies of reading behaviors have yielded interesting and useful findings about how people visually interact with documents. Much of the usability-related research in this area centers on how variations in textual and graphical presentation affect behavior (Brysbaert

[3] The results from home searches typically yield homes listed in a price order from lowest to highest. Since charm pricing results in a greater likelihood of being toward the higher priced home order within the search range, it would seem that charm priced homes would be seen much later by the homebuyer, who might be more prone to fatigue and therefore, skim-reading.

and Vitu, 1998). When readers encounter cognitively complex material, the rate at which they read slows considerably as shown by increases in eye fixation times and number of regressions (backtracking) and decreases in saccade lengths (Liversedge, Paterson, and Pickering, 1998). Furthermore, variations in type sizes affect the normal range of eye fixation durations, saccade movements, and regressions (Tinker, 1963). In studies of online reading, researchers have found that excessive use of color[4] decreased reading speeds by as much as 30 to 40 percent (Krull and Rubens, 1987), although more recent studies have seen an increase in retrieval times – partially due to participants being more familiar with computers (Krull et al., 2004). As with reading, eye tracking research has provided insight into how people scan and search for information online. This has been done in using two methods – (1) in targeted-search studies, people are asked to identify specific information or perform a predefined task, and (2) in free-scan studies, by contrast, people are asked to view a screen or series of screens without any predefined goal.

In general, it has been found that people prefer text over graphics as entry points into Websites (Boaz et al., 2002). Also, eye movements roughly followed the "Z" pattern of design. People's eyes first travel to the upper left corner (typically where the Website identifying logo is placed), across the page to the right corner, and then continue scanning the page in small "z" patterns progressing down the page (Goldberg et al., 2002). Interestingly, scanning did not end at the bottom right corner, but instead continued up the right column of the page.

In addition, small type encouraged focused reading behavior while large type promoted light scanning. When scanning, people are looking for words or phrases that catch their attention. Images of at least 210 X 230 pixels received more eye traffic than smaller images, and people frequently clicked on the 210 X 230 pixel images. Interestingly, scanpath analysis revealed that

[4] The degree of color is typically quantified by dividing the portion of the page that is in color by the total page size. The definition of "excessive" varies from study to study.

users do not necessarily follow the same scanpath for every type of Website. Instead, there appear to be universal scanpaths that people develop based on the function, genre, and design of a Website (Josephson and Holmes, 2002).

Data and Design

To understand how homebuyers search for homes on the Internet, it is necessary to perform tests on actual homebuyers. To this end, we invited 20[5] currently searching or recent (within the last 3 months) homebuyers from the local area who are in the market for a home in the price range of $285,000 - $350,000[6]. As a control group, we also perform our examination on 25 university students[7]. These 45 individuals were shown 10 homes each containing 6 photographs. The result is a cross-sectional dataset containing 450 (45 people x 10 homes) completed home tours and a total analysis of 2,700 (450 x 6) photos[8]. To our knowledge, this constitutes, by far, the largest sample collected in a study using an ocular tracking methodology.

Participants were seated in front of a computer equipped with a 17 inch CRT monitor (optimal for ocular tracking due to its refresh rate). Below the monitor is a desk-mounted, unobtrusive ocular tracking hardware/software (Eyelink 1000) device[9]. When using the device, the participant positions his chin on a padded shelf with his forehead resting against a padded

[5] We split the sample between 10 females and 10 males. Also, for married participants, only one member (husband or wife) was allowed to participate to avoid duplication of stated preferences.
[6] This research was supported by three local real estate brokerage firms who presidents serve on our real estate center's board. These firms kindly directed current clients to us for inclusion consideration.
[7] The overwhelming majority of these types of studies examine only students because it is far easier to collect student data. We are also collecting student data simply to examine how results vary between this convenience sample and those from the population of homebuyers in whose behavior we are most interested.
[8] All photographs used were from homes currently on the market in the local area. Original photographs were obtained directly from REIN, the company in charge of posting photos for the local MLS.
[9] Participants must not be color-blind and must have normal or corrected-to-normal vision, since this is a primarily visual experiment with colored stimuli presented on the computer screen.

frame[10]. Once calibrated for that particular participant, a PC-based remote camera then records all eye movements. The task involves participants taking 10 different home tours on what effectively is the Internet[11]. Our Website intentionally reflects the appearance of those currently in existence. Specifically, there are three primary components of our opening page. The first is an enlarged curb appeal photograph which listing agents hope will catch the eye of the home searcher. Underneath this large photo are five thumbnail pictures of the remaining rooms in the home. The second section is located in the upper right-hand portion of the page and includes property statistics such as square footage, number of bedroom/bathrooms, and so forth. The third and final section of the opening page shares real estate agent remarks, which is an opportunity for the agent to help sell the property through their use of language. Table 1 shares the layout of the Website.

(insert Table 1 here)

Once the opening page is viewed, the homebuyer can search the six component pictures of the house (curb appeal, main living area, kitchen, master bedroom, master bathroom, and view/backyard). The participant is allowed an unlimited time to view each picture and may move forward in the search at any time simply by clicking a button. After the six photos of the first home are shown, the participant is asked a series of short questions which allow for the measurement of the user's ratings. This data was subsequently analyzed via content analysis, a technique described later in this study. Afterwards, the second home is shown, followed by a few

[10] Other than these two somewhat parallel bars, nothing stands in the way between the participant and the monitor.
[11] Technically, the tours take place on a self-contained, originally created program that allows us to completely control the process and avoid outside influences like pop-up advertisements and connectivity loss. The result is a seamless, uninterrupted home tour that allows us to track a myriad of ocular tracking-related variables of interest.

questions about that home, and so forth. After five homes have been toured, the participant is allowed to take a short break and then continue to complete the second half of the tours. At the end of the visual portion of the experiment, the participant is asked to share basic demographic data (such as gender, age, marital status, ethnicity, income, etc.).

For validity of design, we alternate asking these general survey questions at the beginning versus the end of the visual portion of the experiment (to prevent such biases as cognitive anchoring). Other design mechanisms implemented to prevent respondent bias include randomizing the order of the 10 homes that are shown (to prevent order effects), as well as randomizing the order of the six pictures that are shown for each home. The one exception to this rule is that the curb appeal, or outside photo, is always shown first. This is done to be consistent with the way in which the overwhelming majority of Website tours begin. In short, we have made every attempt to minimize the potential for introducing bias, while at the same time keeping the search process as realistic as possible[12]. Because of the expensive equipment used and the need to avoid outside distractions, it was necessary to bring actual homebuyers onto campus and into our laboratory. For this reason, outside homebuyers were compensated with a $50 gas card redeemable at a popular and nearby gas station[13]. Student participants were from Psychology classes and were given experiment participation credit, a practice very common in the field.

Methodology

Since no study of this type has ever been conducted within a real estate setting, the analysis begins with a series of univariate tests and design verification procedures. Afterwards, a direct

[12] The entire process takes between 35-45 minutes to complete.
[13] The institution who supported this research via a large grant did not allow the distribution or handling of cash. The gas card was a way around the rule and thought to be nearly as good as cash.

test of whether or not ocular tracking variables can be used to predict the willingness of a homebuyer to pay for a home is considered based on several variations of the following equation:

Home Value = f {Home Characteristics, Qualitative Variables, Ocular Tracking Variables, Demographic Characteristics, Miscellaneous, error} (1)

Where the specific variables are defined as follows:

Dependent Variables

% List Price	The participant's opinion of fair market value minus list price, divided by list price
Market Value Opinion	Participant's opinion of the fair market value of the home
Worth More Dummy	A dummy variable equal to 1 if the participant estimates the fair market value of the home to be greater than the listing price; 0 otherwise
Worth Less Dummy	A dummy variable equal to 1 if the participant estimates the fair market value of the home to be less than the listing price; 0 otherwise
Overall Home Rating	Participant's overall rating of the home on a scale from 1 (not at all favorable) to 9 (extremely favorable)

A. Home Characteristics

Actual Rating of the Rooms	Participant's ex-post rating of the specific room (photo) for the curb appeal, kitchen, main living area, master bedroom, master bathroom, and backyard/view on a scale from 1 (worst ever) to 9 (best ever)
Importance of the Rooms	Participant's ex-ante importance rating of the specific room (photo) for the curb appeal, kitchen, main living area, master bedroom, master bathroom, and backyard/view on a scale from 1 (not at all important) to 9 (very important)

B. Qualitative Variables

Total # of words	Total number of words the participant used to describe the home after the tour
# positive words	Number of positive words the participant used to describe the home after the tour
% positive words	Percentage of positive words (to total words) the participant used to describe the home after the tour
# negative words	Number of negative words the participant used to describe the

	home after the tour
% negative words	Percentage of negative words (to total words) the participant used to describe the home after the tour

C. Ocular Tracking Variables

Total Dwell Time	Total time spent looking at each picture (in milliseconds)
Fixation Duration	Average time spent at each fixation point within each picture (in seconds)
# of Fixations per picture	Number of points on the screen where the participant's eye stopped (i.e., fixated)
Saccade Count	The number of times the participant's eye jumped from one fixation point to the other
Saccade Amplitude	Average distance between fixation locations (computer screen distance)

D. Demographic Characteristics

Gender	Male = 0; Female = 1
Age	Age in years
Income	Annual income level (0 = $0 - $20,000; 1 = $20,001 - $40,000; 2 = $40,001 - $60,000; 3 = $60,001 - $80,000; 4 = $80,001 - $100,000; 5 = $100,001 - $120,000; 6 = Over $120,000)
College Degree	1 = College degree; 0 = no college degree
Homeowner	1 = Has purchased a home before; 0 = otherwise
Homes Purchased	Number of homes purchased in lifetime
Married	1 = Married; 0 = Single
White	1 = White; 0 = non-White

E. Miscellaneous

Consumption Motive	1 = Consumption motive only; 0 = otherwise
Investment Motive	1 = Investment motive only; 0 = otherwise
% of Search on Web	Home search time spent on the Web (as a percentage of total home search time)
Familiarity with Market	Familiarity with the real estate market in the local area on a scale from 1 (not at all familiar) to 9 (extremely familiar)
Charm Pricing Dummy	1 = Charm Pricing was used in the list price; 0 = otherwise

Dependent Variables

Agarwal (2007) and Seiler et al. (2011) document that people are not proficient at identifying the true value of the home in which they live. If this is the case, then asking them to accurately place a fair market value on a home they have only visited through a virtual home tour would seem more daunting. Still, in economics, finance and real estate, we are concerned with the amount

people are willing to pay for a home more so than just how a person rates the overall quality of the home. While we agree that a measure of a homebuyer's willingness to pay is a preferred measure to a simple rating of the home, we also recognize the difficulties in collecting this data through a controlled experiment. For this reason, we collect both measures and perform a series of regressions for both. Additionally, we further segment the analysis based on those who believe the home they toured is worth more (or less) than the listing price offered by the selling agent via a series of logistic regressions.

A. Home Characteristics

Ex-ante homebuyer stated preferences are collected in terms of which rooms inside the house they believe to be the most important in the final assessment of whether or not they will like the home. These importance measures are then correlated with the ex-post ratings of how much the homebuyer liked the rooms as well as the overall home rating. Real estate agents often use the phrase "buyers are liars" to describe the frustration of showing clients exactly what they ask to see only to eventually have them buy a property whose attributes do not even remotely resemble the original "must have" list. While it is not the central focus of our investigation to fully pursue this research question, we do take a cursory glance at the issue.

B. Qualitative Variables

Buying a home can be a very difficult and time consuming process. Not only is the purchase likely the largest an individual will ever make, but the selection of a home is one based on both economics and emotion. After completing the tour of each residence, we pause and ask participants to share the words that come to mind when thinking about the home they just toured.

The list of forthcoming words may at times seem to represent a stream of unconsciousness. However, using textural data analysis techniques such as those in Doran, Peterson, and Price (2011), Dempsey et al. (2011) and (Li 2008), it is possible to classify these words as being positive, negative, or neutral. From this process, we are able to create and include in our quantitative analysis a number of variables that were previously considered too qualitative.

C. Ocular Tracking Variables

One of the key contributions of this study is to quantify variables that have previously been impossible to capture. Through the use of modern technology, we are able to record with incredible precision five key ocular tracking variables. The first is the total dwell time (in milliseconds) that each participant spends looking at each of the 2,700 photos in our sample. Past studies have shown that an increase in total dwell time is an indication of interest by the viewer. As such, we hypothesize dwell time to have a positive association with interest in the photo. A second captured measure is the number of fixation points (referred to as fixation count) when viewing each of the photos. Fixation points represent locations where the viewer has slowed down to take a closer look at the photo. Fixation duration is the average time spent at each fixation point (typically in milliseconds). We similarly hypothesize a greater number of fixation points to be an indicator of either greater interest or more effort expended in viewing the image since evidence indicates that intense cognitive processing occurs during a fixation (Rayner, 1998).

Saccade count is the number of times the participant's eye jumped from one fixation point to the other. A related measure is saccade amplitude. This variable measures the average distance between fixation locations. Although there are several different interpretations of a

saccade in the ocular tracking literature, it is generally accepted that when a saccade occurs, information is being suppressed (Rayner, 1998). Thus, the greater the number and length (amplitude) of saccades the less an individual was focusing on or actively interpreting the information in front of them; this could mean that greater saccade counts and longer saccade amplitudes imply: (1) a lower level of interest in the visual scene, or (2) a higher level of familiarity with the task/context and low need to search very thoroughly. Each of the five ocular tracking variables is collected for all 2,700 photos viewed in this study.

D. Demographic Characteristics

Because people of all demographic profiles search for homes on the Internet, it is not the focus on this study to examine the scanpath differences by demographic characteristics. Still, the data does allow for the inclusion of these as control variables. It is also of interest to see how the results change when moving from actual homebuyers to a convenience sample containing only students. As previously stated, the overwhelming majority of experiments are conducted on student samples due to ease of access. The question is the degree to which students provide a sufficient proxy for a sample of actual homebuyers.

E. Miscellaneous

Flachaire, Hollard, and Luchini (2003) used a novel approach to measure a variable they termed "conformist versus non-conformist" in a study of a participant's willingness to pay for admission to a park. The process involves respondents answering a simple open-ended question, "When you think of (the park), what words come to mind?" Then, after a series of iterative steps similar to a factor analysis, a dummy variable is formed which

allows for a quantification of a previously strictly qualitative concept. We adopt this approach to see if the manner in which a homebuyer views his home (as a consumption good versus an investment) influences his willingness to pay for the property.

The percentage of search time on the Web is also collected with the notion that more experienced Web searchers might view Webpages differently than those who are new to the process. For example, experienced searchers likely do not need nearly as much time to view an Internet real estate listing because they have seen so many already and presumably know what they are looking for. Our next independent variable is familiarity with the local residential real estate market. Increased familiarity should also influence the search process in a manner similar to experience on the Web.

Charm pricing is an employed marketing technique whereby the list price of a residence is set just below a round number (e.g., $299,900 versus $300,000). While several studies, such as Miller and Sklarz (1987), Kang and Gardner (1989), Asabere, Huffman, and Mehdian, (1993), Knight, Sirmans, and Turnbull (1994), and Benjamin and Chinloy (2000), have examined the relationship between list price and sales price in a macro sense, only two studies have directly examined charm pricing in residential real estate. Allen and Dare (2004) examined transactions in south Florida and found charm pricing in listed properties to lead to higher transaction prices. In direct contrast to their study, Palmon, Smith, and Sopranzetti (2004) found the opposite result when examining price behavior in Texas. Because the literature remains sparse in the charm pricing area, we include this variable as a secondary contribution of this study.

Results

(insert Table 2 here)

Panel A of Table 2 displays the total dwell times by the order in which the house was shown. Recall that the home order was semi-randomized to prevent order effects bias in the results. What is evident from the table is that the first home shown to participants took longer to view than the homes shown later in the experiment. A learning curve such as this completely expected with any new experience. So while the homebuyer has searched for homes on the Internet before, this is the first time they have seen our Website. The curve levels off almost immediately as dwell time to view homes in positions 2 through 10 are rarely significantly different from each other. Since most home search engines show results sorting prices from low to high, sellers might want to list their homes at the very bottom of the pricing interval. This would cause their home be shown first, which is associated with a longer dwell time by the potential buyer[14].

Panel B considers the order effects of rooms within the home. Recall that the curb appeal photo was always shown first to the participant as this is the common industry practice. Photos two through six randomly shuffle through the remaining rooms of the house which is also consistent with both cyberspace and physical tours of a home. ANOVA and Post Hoc tests reveal very few significant differences in dwell times for any of the rooms. This suggests that participants maintained a fairly consistent speed while scrolling through the Website.

(insert Table 3 here)

Summary statistics for the dependent variables in Equation (1) are listed in Panel A of Table 3. As expected, both homebuyers and students estimate the true market value of the home to be less

[14] Clearly, this only makes sense if the market value of their home is extremely close to the lower pricing level already.

than the list price. This is consistent with both observational intuition and cognitive anchoring hypotheses. Both groups estimate prices to be over-stated by roughly 5% - 6%. Interestingly, homebuyers report a higher market price for the homes, but a lower overall rating when compared to students. This conflicting result is often argued to exist in studies that are published in psychology versus real estate/finance journals and was the impetus for collecting both metrics in this investigation. There are no statistically significant differences in Panel A, however.

Panel B displays the ex-post or actual ratings for each photo of the house followed by the ex-ante stated level of importance when evaluating a residence. While four of the six importance ratings are statistically significantly different between the two groups of sample participants, only one (a different room) was significant in terms of ex-post evaluation. After the home was toured, participants were asked what words come to mind when thinking of the home just toured. Using content analysis (Berelson, 1952), these terms were coded based on three concepts: positivity, negativity, and neutrality. Using responses to the survey questions given to each participant in the beginning (or ending – for the other half of the sample) of the study, each word was then further coded based on a relational analysis, meaning that we coded for the underlining concept of each word cross-referenced with the participant's verbal description of each property immediately after it was viewed. Coding participant data in this manner is a typical method for trying to understand the mental models participants construct (Flachaire, Hollard, and Luchini, 2003; Carley and Palmquest, 1992). While homebuyers use significantly more words to describe the home, students and homebuyers are remarkably similar in both their number and percentage of positive and negative words.

Significant differences between homebuyers and students only begin to emerge when considering the ocular tracking variables presented in Panel D. Specifically, homebuyers take

significantly less time to view each room in the house when compared to students. This result is fully anticipated given that homebuyers have already been searching for homes and therefore better know what they are looking for when perusing a Website. A similar pattern of significant differences between homebuyers and students is seen in the number of fixations per picture and saccade count. Consistent with our expectations, experienced homebuyers fixated less and demonstrated fewer saccades indicating that experience and familiarity with the context compensated for the need to search thoroughly. However, this could also be an indication of low interest in the Website display (Rayner, 1998), which poses an additional challenge when designing for the experienced buyer. Without the use of ocular tracking technology, these challenges would never be known.

Understandably, the demographic profile of a typical student differs greatly from that of a typical homebuyer. For example, homebuyers in our sample are significantly older, earn more income, have a higher level of education, have owned more homes in the past, and are more likely to be married. Simply put, they are further along in life. Homebuyers have a significantly greater percentage of search time on the Web and a greater familiarity with the local residential real estate market. Finally, homebuyers are more likely to consider the investment component of a home when making a purchase. In fact, not one of the 25 students associated strictly investment related words when buying a home compared to 16% of homebuyers. Similarly, the consumption only motive was mentioned in 80% of student cases as opposed to just 62% of homebuyers. Clearly, a homebuyer is thinking more in terms of both consumption and investment when searching for a home.

In sum, while the demographic profile between homebuyers and students are significantly different across almost every measure, and while the groups do not seem to agree on what they

are looking for in a home (ex-ante), the ex-post results reported thus far are strikingly similar with the exception of three of the five ocular tracking variables.

(insert Table 4)

Table 4 displays the sequence in which participants viewed the three sections of each Webpage. Panel A reveals the analysis associated with the curb appeal photo – which is always the first photo seen by the participant. Overwhelmingly (95.1%), participants first look at the picture of the home. After focusing on the photos, participants next turn to the quantitative property description section where the number of bedrooms, bathrooms, square footage, etc., are displayed. Finally, the real estate agent's open remarks section is viewed. Very little emphasis is placed on this section. In fact, over 40% of all participants (20% of homebuyers; 62% of students) do not even look at the real estate agent remarks section when viewing the first page of the home tour. In our experiment, participants comply by viewing the remainder of the home, but in an actual setting, one has to wonder if the agent remarks would ever get read if the home searcher does not like the initial photo of the home.

Panel B of Table 4 reports the sequence of viewing for a later page in the home tour. Recall that after the curb appeal, the remaining rooms are rotated to appear in any order. As such, we sample the main living area and generate viewing patterns for these rooms. Similar to the curb appear, participants clearly focus on the photo of the room as opposed to reading the quantitative property description, and finally the agent's remarks. This is understandable since these latter two areas have been present on every page of the web tour, whereas the photo is new on each subsequent page.

Concerning parsing of the data, homeowners are much more likely to view all three sections of the Webpage whereas students focus much more on the photos. This is understandable as homebuyers are actually in the market to buy these properties, and as such, need to collect as much information as possible to reach an informed decision. Gender did not play a role in determining search sequence.

(insert Table 5)

Panel A of Table 5 correlates dwell time with the ex-ante stated preference of what is important to sample participants. Correlation coefficients are either insignificantly different from zero or significantly negative. The interpretation is that a person does not have to look at a photo for a long time to gather from it the information necessary to reach a conclusion. In fact, the opposite is true. People seem to be more efficient at gathering information when the photo is of greater importance. Panel B of the table relates the ex-post evaluations of the overall home rating to the individual rating of each room. While all rooms are significantly positively correlated with the overall rating, no room in particular stands out as being a better indicator of the overall evaluation of the home. Finally, Panel C correlates the five ocular tracking variables to decide which ones should not be included in the estimation of Equation (1) due to multicollinearity concerns.

(insert Table 6 here)

Table 6 reports the results from six different variations of estimates to Equation (1)[15]. In the first three regressions, the dependent variable is the participant's estimate of the home's value as a percentage of the list price. Recall that price is a measure more palatable to real estate economists. The fourth through sixth regressions have the overall home rating on a scale from 1 to 9 as the dependent variable – a measure used more in psychology studies. Unreported correlations indicate that multicollinearity concerns prevent the inclusion of all the demographic variables. Therefore, in the first regression, a dummy variable for participant type will be used to capture differences that exist between homebuyers and students. Consistent with the results in Table 3, homebuyers and students are heterogeneous between groups, but extremely homogeneous within each group. As such, only low correlated variables are included in each subsequent regression.

As hypothesized, the percentage of negative words is significantly negative in all three regressions[16]. Total dwell time and fixation duration is significantly positive and driven primarily by the student sample, while the statistically negative coefficient on saccade amplitude is driven primarily by the homebuyer sample. Homebuyers with a higher income perceive prices to be significantly lower than lower income buyers, presumably because they are in the market for higher priced (and therefore, nicer) homes. The same relationship is true for experienced homebuyers. They appear not to be as easily impressed as less seasoned buyers. Consistent with univariate tests, the negative coefficient on the participant type dummy variable indicates that students perceive the value of homes within the sample to be lower than the perception of value by homebuyers. Finally, our significantly negative coefficient on charm pricing is consistent with

[15] Because each participant views 10 homes, we include in all regressions nine (n-1) "home number" dummy variables to control for fixed effects.

[16] When the percentage of positive words is included instead, the result is a consistently positive and significant coefficient. As such, either variable (but not both due to their significant negative correlation) can be used in the regressions.

Palmon, Smith, and Sopranzetti (2004) in that the technique works in the opposite direction as intended.

When comparing the results from the percentage of list price regressions to the results from the overall home rating regressions, the dependent variable does seem to make a difference. The sign changes for three of the variables (total dwell time, consumption motive, and participant type). In two of the cases, the variable becomes insignificant, but in the case of the consumption motive, the sign changes direction and significance. While it is not possible to know which dependent variable is a better choice on which to base the analysis, it is simply our purpose to identify the fact that the two measures, at times, yield significantly different results. This is a topic we suggest future studies delve into further.

(insert Table 7 here)

Table 7 reports six separate logistic regression results from two variations of Equation (1). Otherwise similar to the specifications in the prior table, the new dependent variable for the first three columns is a dichotomous variable, set equal to one if the participant believes the home is worth *more* than the list price and zero otherwise. In the last three logistic regressions, the dependent variable is set equal to one if the participant believes the home is worth *less* than the list price. For the full sample logistic regression in the first column, as expected, the percentage of positive words carries a significantly positive coefficient as does total dwell time and fixation duration. These results are clearly driven by the student portion of the sample where the signs and significance levels are consistent. Alternatively, for the homebuyer sub-sample, only the numbers of homes purchased in the past is significant.

In the three logistic regressions attempting to model the causes of participants who believe a home is worth less than its list price, the percentage of negative words used to describe the house replaces the percentage of positive words. Consistent with expectations, the coefficient is positive and significant. The signs for fixation duration and saccade amplitude have switched when moving from the worth *more* to worth *less* regressions, as expected. Fixation duration not only switched signs, but also retained its statistical significance. We interpret this to mean that when a person likes the home, they will fixate for greater periods of time. But, when they do not like the home, they will experience shorter fixation periods. In both of the full sample logistic regressions, the variable, participant type, is not significant.

Charm pricing results in this table are consistent with the prior table. Specifically, in the first three columns, the charm pricing dummy carries a significantly negative signal indicating that its use resulted in fewer homebuyers evaluating the home as being worth more than the list price. Consistently, in the last three columns, the coefficients on charm pricing are all significantly negative indicating a symmetrical relationship. The conclusion is that charm pricing worked against its intended purpose, consistent with the findings of Palmon, Smith, and Sopranzetti (2004), but opposite the conclusions Allen and Dare (2004).

Conclusions

This study compared the results of actual homebuyers versus the convenience sample of student participants. While the demographic differences are in stark contrasts, the results typically are not. However, significant differences are observed in a number of the ocular tracking variables used in this study: total dwell time, number of fixations, and saccade count. We find that homebuyers, and much more so students, focus primarily on the photo of the home and

secondarily on the quantitative description of the property. Real estate agent remarks are substantially lower on the list of priorities. Just over 40% of participants did not view the real estate agent remarks when looking at the first page of the Website. This speaks to the revealed importance of real estate agent remarks to home searchers. In an examination of home prices, we find that charm pricing has the opposite effect as intended (a negative relationship with price). Previously, the literature was mixed on the success of this marketing technique.

Since this is the first study to use ocular tracking technology in a real estate setting, we focused on fundamental concepts and an exploratory understanding of how people search for homes on the Net. Future studies should extend the work described here by testing the impact on various Website designs. By performing a similar analysis to ours, after altering the layout of the page, real estate agents can begin to learn which designs best grab the homebuyer's attention. Moreover, in future studies, it would be beneficial to simply observe homebuyers in their natural element where they are free to continuously surf the Internet for homes without having to pause periodically and answer questions about what they have just seen. Still, the first steps taken in the current investigation are necessary groundwork that needs to be laid before these more advanced investigations can be considered.

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Table 1. Sample View of the Website Design with a Typical Ocular Tracking Variable Analysis Superimposed

This table shows the first page the participant sees when he begins the tour of a home. Additionally, this picture also includes an indication of the "Interest Areas" as well as various superimposed Ocular Tracking measures.

Table 2. Total Dwell Time versus Order in Which House and Room Were Shown

Panel A of this table shows the dwell times for the homes that appear in the first through tenth positions. Panel B displays total dwell times for the order in which the room was shown. The curb appeal photo was always shown first. The home order and all other rooms were randomized to avoid biasing the results.

	Overall	Curb Appeal	Kitchen	Main Living Area	Master Bedroom	Master Bathroom	Backyard/ View
Panel A: Total Dwell Time by house							
Home Pos 1	64,590***	21,653	8,677	9,801**	9,701***	8,996**	9,483**
Home Pos 2	56,963	20,311	6,872	8,086	7,454*	7,812	7,208**
Home Pos 3	57,909*	22,012	8,794	9,073**	8,984***	8,245	8,274
Home Pos 4	55,982	19,203	8,402	7,508	8,449***	7,238*	9,223*
Home Pos 5	56,231	19,757	7,418	8,692	8,001	8,576	8,127
Home Pos 6	55,369	20,234	7,451	7,709	7,706	7,676	6,974**
Home Pos 7	56,886	20,401	8,797	7,210*	7,532	7,955	8,635
Home Pos 8	50,437*	17,701	7,517	8,062	6,672***	7,964	8,169
Home Pos 9	54,700	18,762	7,179	7,483	6,704***	6,926**	8,804
Home Pos 10	55,827	20,445	8,075	6,977**	6,891***	7,653	7,394*
ANOVA F-statistic	1.30 (.232)	0.42 (.924)	1.35 (.208)	1.44 (.169)	2.32** (.015)	0.68 (.727)	1.10 (.360)
Panel B: Total Dwell Time by Order Room was Shown							
Rm. Order 1		20,052					
Rm. Order 2			8,103	9,639*	7,650	9,680	9,300
Rm. Order 3			8,692*	7,551	7,784	7,877	8,193
Rm. Order 4			8,171	7,425*	8,176	7,697	8,849
Rm. Order 5			7,118*	7,374	7,425	7,401	8,280
Rm. Order 6			7,221	8,284	7,884	7,192	7,069
ANOVA F-statistic			1.93 (.104)	0.83 (.509)	0.78 (.537)	0.48 (.753)	0.35 (.845)

1. Overall column significance levels are based on ANOVA Tests.
2. Significance indicators within specific cells are based on Post Hoc tests. Specific tests were selected after a Levene statistic was computed in order to make the correct assumption regarding homogeneity of variance.

*** Significance at 1%; ** Significance at 5%; * Significance at 10%

Table 3. Descriptive Statistics by Sample Participants

This table displays minimum, maximum, and mean values for the three categories of participants: full sample, homebuyers, and students.

	Full Sample			Homebuyers			Students		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Panel A: Dependent Variable									
% List Price	-0.54	0.83	-5.07%	-0.42	0.83	-4.22%	-0.54	0.25	-5.75%
Market Value Opinion	150,000	550,000	301,164	185,000	550,000	303,776	150,000	400,000	299,074
Worth More Dummy	0	1	.20	0	1	.16	0	1	.22
Worth Less Dummy	0	1	.56	0	1	.58	0	1	.55
Overall Home Rating	1	9	6.52	1	9	6.45	3	9	6.57
Panel B. Home Characteristics									
Actual Rating									
Curb Appeal	1	9	6.46	1	9	6.40	2	9	6.50
Kitchen	1	9	6.26	2	9	6.14	1	9	6.36
Living Room	1	9	6.13*	1	9	5.97	2	9	6.26
M. Bedroom	1	9	5.95	2	9	5.97	2	9	5.94
M. Bathroom	1	9	6.16	2	9	6.19	2	9	6.14
Backyard/View	1	9	6.19	1	9	6.26	1	9	6.13
Importance									
Curb Appeal	2	9	6.78*	2	9	7.35	3	9	6.32
Kitchen	3	9	7.79**	3	9	7.62	6	9	7.92
Living Room	4	9	7.69	5	9	7.65	4	9	7.72
M. Bedroom	4	9	7.60**	4	9	7.45	5	9	7.72
M. Bathroom	3	9	7.29	4	9	7.35	3	9	7.24
Backyard/View	2	9	7.24**	2	9	7.05	4	9	7.40
Panel C: Qualitative Variables									
Total # of words	1	8	3.24**	1	8	3.39	1	7	3.12
# positive words	0	7	1.56	0	7	1.61	0	6	1.53
% positive words	0	1	48.07	0	1	45.53	0	1	50.10
# negative words	0	5	0.93	0	4	0.88	0	5	0.97
% negative words	0	1	30.89	0	1	28.26	0	1	32.99
Panel D: Ocular Tracking Variables									
Total Dwell Time									
Overall	6,082	168,749	56,488	27,720	168,749	57,164	6,082	141,379	55,945
Curb Appeal	5,658	94,300	20,052**	5,658	45,200	18,533	5,907	94,300	21,266
Kitchen	2,898	33,131	7,917***	2,929	18,152	7,229	2,898	33,131	8,458
Living Room	1,685	45,098	8,058***	1,685	34,942	7,362	2,728	45,098	8,612
M. Bedroom	1,361	42,189	7,817***	2,451	28,323	6,891	1,361	42,189	8,550
M. Bathroom	2,963	42,535	7,902***	2,963	34,569	6,861	3,240	42,535	8,733
Backyard/View	2,788	65,715	8,228***	2,981	33,411	7,443	2,788	65,715	8,845

Fixation Duration									
Overall	109	729	263.76	109	436	259.67	112	729	267.02
Curb Appeal	49	489	253.40	49	439	249.66	90	489	256.39
Kitchen	48	566	253.07	48	503	252.76	70	566	253.32
Living Room	51	553	259.93	72	553	259.11	51	485	260.58
M. Bedroom	61	582	251.57	61	582	250.42	62	474	252.48
M. Bathroom	39	778	251.80	56	778	251.89	39	433	251.73
Backyard/View	60	533	253.53	63	533	253.82	60	502	253.30
# of Fixations per picture									
Overall	14	514	156.59***	18	514	166.22	14	349	148.89
Curb Appeal	3	265	60.74	3	161	59.05	16	265	62.10
Kitchen	4	111	24.40**	4	64	22.83	6	111	25.64
Living Room	5	117	24.39*	7	104	22.91	5	117	25.56
M. Bedroom	2	119	24.05**	2	119	22.15	3	117	25.56
M. Bathroom	3	113	24.53***	3	113	21.73	4	111	26.76
Backyard/View	3	163	24.77*	3	113	23.22	5	163	25.99
Saccade Count									
Overall	2	513	154.55**	2	513	163.29	14	349	147.55
Curb Appeal	2	264	60.10	2	161	58.21	15	264	61.61
Kitchen	3	111	24.31**	3	64	22.65	6	111	25.61
Living Room	2	116	24.16**	2	104	22.49	4	116	25.49
M. Bedroom	2	120	23.94***	3	120	21.98	2	117	58.48
M. Bathroom	3	113	24.40***	3	113	21.54	4	111	26.66
Backyard/View	2	163	24.67*	2	113	23.06	5	163	25.94
Saccade Amplitude									
Overall	2	11	3.13***	2	11	3.37	2	5	2.94
Curb Appeal	1	11	2.78	1	11	2.75	1	6	2.80
Kitchen	1	11	2.98	1	11	2.98	2	7	2.97
Living Room	1	13	2.95	1	13	3.02	1	6	2.90
M. Bedroom	1	10	3.11	1	10	3.05	2	7	3.16
M. Bathroom	1	15	3.09	1	15	3.13	2	6	3.05
Backyard/View	2	21	2.93	1	21	2.98	1	6	2.90
Panel E: Demographic Variables									
Males	0	1	40%***	0	1	50%	0	1	32%
Age	18	54	29.60***	22	54	37.35	18	43	23.40
Income	0	6	1.69***	0	6	2.85	0	5	0.76
College Degree	0	1	36%***	0	1	75%	0	1	4%
Homeowner Dummy	0	1	53%***	0	1	90%	0	1	24%
Homes Purchased	0	8	1.24***	0	8	2.40	0	2	0.32
White Dummy	0	1	73%***	0	1	85%	0	1	64%
Married Dummy	0	1	36%***	0	1	55%	0	1	20%
Panel F: Miscellaneous Variables									
Consumption Motive	0	1	62%***	0	1	40%	0	1	80%
Investment Motive	0	1	16%***	0	1	35%	0	1	0%
% of Search on Web	0	100	59%***	2	100	71%	0	100	48%
Familiarity w/ Market	1	9	4.22***	1	9	5.10	1	7	3.52

Charm Pricing	0	1	40.0%	0	1	40.0%	0	1	40.0%

*** Significance at 1%; ** Significance at 5%; * Significance at 10%

2. Significance is based on Independent Samples T-Tests. Specific tests were selected after a Levene statistic was computed in order to make the correct assumption regarding homogeneity of variance.

Table 4. Viewing Order for the Curb Appeal and Main Living Areas

This table reports the viewing sequence of both the curb appeal page and the page associated with the home's main living area.

Viewing Sequence	Photo	Quantitative Property Description	Agent Remarks
Panel A: Curb Appeal Sequential Analysis			
Viewed First	95.1%	2.4%	2.4%
Viewed Second	2.4%	75.6%	7.3%
Viewed Third	2.4%	7.3%	48.8%
Not Viewed	0.0%	14.6%	41.5%
Panel B: Main Living Area Sequential Analysis			
Viewed First	87.8%	7.3%	4.9%
Viewed Second	12.2%	29.3%	2.4%
Viewed Third	0.0%	2.4%	4.9%
Not Viewed	0.0%	61.0%	87.8%

Table 5. Selective Correlations Coefficients by Sample Participants

This table displays correlation coefficients between selected potential independent variables for the three categories of participants: full sample, homebuyers, and students.

Panel A: Importance and Dwell Time

	Full Sample (N = 450)	Homebuyers (N = 200)	Students (N = 250)
Curb Appeal	-.004	-.046	.073
Kitchen	-.085*	-.154**	-.076
Living Room	-.036	-.140**	.021
M. Bedroom	-.197***	-.282***	-.188***
M. Bathroom	-.148***	-.231***	-.104
Backyard/View	-.147***	-.218***	-.135**

Panel B: Overall and Room Ratings

	Curb Appeal	Kitchen	Living Room	M. Bedroom	M. Bathroom	Backyard/View
Kitchen	.401***					
Living Room	.408***	.595***				
M. Bedroom	.484***	.525***	.631***			
M. Bathroom	.493***	.490***	.547***	.611***		
Backyard/View	.295***	.369***	.440***	.450***	.384***	
Overall	.512***	.513***	.535***	.537***	.490***	.509***

Panel C: Ocular Tracking Variables: Curb Appeal[1]

	Total Dwell Time	Fixation Duration	# of Fixations	Saccade Count
Fixation Duration	.216***			
# of Fixations	.929***	.067		
Saccade Count	.922***	.059	.996***	
Saccade Amplitude	-.144***	-.218***	-.196***	-.191***

*** Significance at 1%; ** Significance at 5%; * Significance at 10%

1. Correlation coefficients are qualitatively similar no matter which room is considered.

Table 6. Regression Results by Sample Participants

This table reports the regression results from 6 separate regressions based on Equation 1 after removing independent variables that are too highly correlated. The dependent variable is the participant's opinion of value as a percentage of list price. Independent variables include the percentage of words used to describe the home which are negative; total dwell time; fixation duration; saccade amplitude; participant income; total homes purchased in lifetime; a dummy variable for the consumption motive where 1 = participants who expressed words for home ownership that only relate to the consumption component of owning a home, and 0 otherwise; a dummy variable for charm pricing where 1 = charm pricing was used, and 0 otherwise; and participant type where 0 = homebuyers, and 1 = students.

	Percentage of List Price			**Overall Home Rating**		
	Full	Homebuyers	Students	Full	Homebuyers	Students
% Negative Words	-.094*** (.017)	-.103*** (.025)	-.079*** (.022)	-1.545*** (.165)	-1.842*** (.251)	-1.235*** (.213)
Total Dwell Time	5.85^{-7}** (.000)	2.28^{-7} (.000)	1.01^{-6}*** (.000)	-4.29^{-6} (.000)	-9.93^{-6}** (.000)	-1.99^{-8} (.000)
Fixation Duration	.000** (.000)	.000 (.000)	.000*** (.000)	.001 (.001)	.000 (.002)	.001 (.001)
Saccade Amplitude	-.010* (.006)	-.014** (.007)	-.018 (.013)	-.006 (.058)	-.056 (.069)	-.005 (.128)
Income		-.009** (.005)			-.021 (.046)	
Homes Purchased		-.015*** (.004)			-.182*** (.044)	
Consumption Motive		.0113 (.018)			-.318* (.182)	
Charm Pricing	-.112*** (.025)		-.074** (.032)			
Participant Type	-.017 (.011)			.163 (.111)		
Sample Size	450	200	250	450	200	250
F-Statistic	10.575***	6.114***	8.596***	13.314***	9.179***	7.724***
Adjusted R-Squared	.232	.296	.285	.280	.402	.261

*** Significance at 1%; ** Significance at 5%; * Significance at 10%

1. The nine (n-1) "house number" fixed effects variables are suppressed for the sake of brevity, but are available from the authors upon request.

Table 7. Logistic Regression Analysis for the Dichotomous Dependent Variables Indicating Whether the Home is Worth More or Less than the List Price

This table reports the regression results from 6 separate regressions based on Equation 1 after removing independent variables that are too highly correlated. The dependent variable in the first three regressions is a dummy variable where 1 = the participant's opinion of value is greater than the list price, 0 otherwise. The dependent variable in the last three regressions is a dummy variable where 1 = the participant's opinion of value is less than the list price, 0 otherwise. Independent variables include the percentage of words used to describe the home which are negative; total dwell time; fixation duration; saccade amplitude; participant income; total homes purchased in lifetime; a dummy variable for the consumption motive where 1 = participants who expressed words for home ownership that only relate to the consumption component of owning a home, and 0 otherwise; a dummy variable for charm pricing where 1 = charm pricing was used, and 0 otherwise; and participant type where 0 = homebuyers, and 1 = students.

	Worth More Dummy			**Worth Less Dummy**		
	Full	Homebuyers	Students	Full	Homebuyers	Students
% Positive Words	1.292*** (.410)	.156 (.641)	2.399*** (.613)			
% Negative Words				1.582*** (.355)	2.144*** (.636)	1.270*** (.469)
Total Dwell Time	.000* (.000)	.000 (.000)	.000*** (.002)	.000 (.000)	.000 (.000)	.000 (.000)
Fixation Duration	.005*** (.002)	.001 (.004)	.007*** (.002)	-.006*** (.002)	.001 (.004)	-.008*** (.002)
Saccade Amplitude	-.150 (.153)	-.226 (.204)	-.156 (.342)	.050 (.116)	.153 (.160)	-.252 (.275)
Income		.048 (.137)			.008 (.106)	
Homes Purchased		-.278* (.162)			.459*** (.122)	
Consumption Motive		.735 (.521)			-.928** (.435)	
Charm Pricing	-2.435*** (.688)	-1.921** (.916)	-3.462*** (1.156)	1.997*** (.496)	2.338*** (.815)	2.140*** (.686)
Participant Type	.303 (.278)			-.180 (.225)		
Sample Size	450	200	250	450	200	250
Overall Model Chi-Square	89.60***	37.53***	79.45***	107.65***	71.41***	75.53***
-2 Log Likelihood	355.76	140.16	186.00	502.92	195.69	267.53
Cox and Snell R-Square	.182	.174	.273	.215	.305	.262
Nagelkerke R-Square	.288	.292	.417	.288	.410	.350
% Correctly Classified	81.6%	86.2%	82.3%	70.31%	77.0%	74.7%

*** Significance at 1%; ** Significance at 5%; * Significance at 10%

1. The nine (n-1) "house number" fixed effects variables are suppressed for the sake of brevity, but are available from the authors upon request.