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Eye movements on restaurant menus: A revisitation on gaze motion and consumer scanpaths

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ABSTRACT

Menu designers have based design tactics on roughly applied psychological foundations. In particular, attention and memory-based design placement strategies are founded upon assumptions which necessitate a clear idea of consumer eye movement sequences across restaurant menus. The aim of this paper is twofold. First, a review of academic and practitioner literature is presented to frame the current discussion on gaze motion patterns as applied to restaurant menus. Second, the results of an eye-tracker study are presented as an empirical and more quantitatively analyzed replication of past restaurant gaze-motion studies. Results offer an average menu scanpath, show that observed consumer scanpaths differ from those anecdotally espoused by industry, and suggest traditional menu "sweet spots" may not exist.

1. Introduction

1.1. Menu design strategies

The general strategy of restaurant menu engineering is to efficiently convey enough information to customers so that they happily choose to consume what menu engineers prefer them to buy. Most main-stream menu design tactics focus on content presentation – how to draw or increase attention to targeted items or menu categories. While it is true that customers cannot buy what they cannot see – it is counter to prior research and presumptuous to assume that increased item awareness will significantly increases purchase likelihood (Carmin and Norkus, 1990; Reynolds et al., 2005). In other words, we know consumers cannot buy a product if they do not know it exists; but just because consumers know a product exists, does not mean they will be more likely to buy it. Yet popular menu design recommendations often focus on making sure consumers know that certain products exist by drawing repeated attention to them or by making them more memorable. For example, items targeted for increased promotion through design are recommended to be: boxed or highlighted (Hopkins, 2005; Hug and Warfel, 1991; Hunt-Wesson Foodservice, 1999; Stoner, 1986), placed at the top or bottom of a category list (Gallup, 1987; Hopkins, 2005), or placed in sweet spots where guest scanpaths pass through most frequently (Gallup, 1987).

These design recommendations are based on two well-known effects in psychology and cognitive science: the serial position effect (commonly referred to as the rules of recency and primacy) (Ditmer and Griffin, 1994; Miller, 1992; National Restaurant Association [NRA], 2007; Pavesic, 2011; Sysco Food Service, 2011), and the Von Restorff effect. The serial position effect refers to a person's over all ability to more accurately recall the first (primary) and last (most recent) items of a list than to recall any other item on that list (McCrary and Hunter, 1953). Similarly, the Von Restorff effect refers to a person's ability to more accurately recall distinctive items from a list; those items that are presented in such a way where they somehow violate the prevailing context of the over all presentation (Hunt, 1995). As applied to restaurant menu items or even entire menu categories, suggested tactics for utilizing increased distinctiveness have come in many forms: font color (NRA, 2007), "imaginative embellishment" of item copy (Livingston, 1978), vivid presentation (Panitz, 2000; Pavesic, 1999), or the aforementioned highlighting and boxing. However, whatever the source(s) of distinctiveness, Von Restorff demonstrated that vividness or perceptual salience was not a prerequisite for improved memorability (Hunt, 1995); which brings into question the applicability of attention-grabbing tactics with regard to menus. Within the context of a full service restaurant where guests have the liberty of perusing the menu at their leisure, it is arguable whether item memorability alone is all that relevant to purchase behavior.

Despite the lack of empirical evidence linking primacy and recency with either memorability or purchase behavior with restaurant menus, practitioners continue to advocate the use of menu 'sweet spots' – where consumers tend to focus on or look

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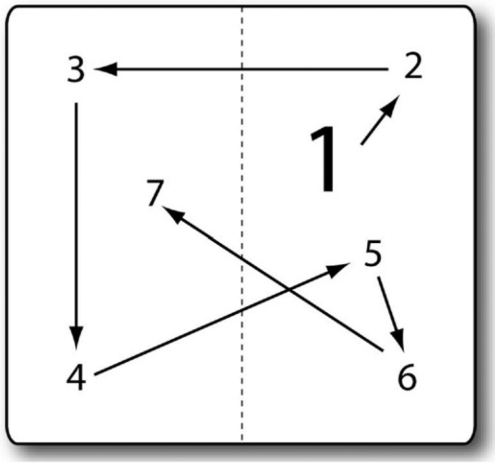

Fig. 1. Two-page scanpath (industry convention).

to first, last, or most frequently (NRA, 2007; Ninemeier and Hayes, 2003; Pavesic, 1999).

Fig. 1 shows the scanpath thought to dominate consumer reading patterns of two-page restaurant menus (Bowen and Morris, 1995; Hug and Warfel, 1991; Kelson, 1994; Kotschevar, 2008; Main, 1994; Miller, 1992; NRA, 2007; Panitz, 2000; Pavesic, 2011; Scanlon, 1998). Although the scanpath depicted in Fig. 1 is often cited by menu design literature, its pattern has not been empirically validated nor has its underlying reasoning been explained. Despite the lack of critical evaluation of the scanpath shown in Fig. 1, industry convention follows that the most desirable locations on the menu would lie at positions 1 (primacy), 7 (recency), and perhaps position 5 (where the gaze pattern would pass through most frequently).

Similarly, one of the first academically published maps of customer focal points was espoused by a well-known menu and graphic designer of the time, William Doerfler. Doerfler suggested that the consumer focus on a single-fold menu with two facing pages lies in the region above a diagonal line cutting across both facing pages (shaded region in Fig. 2). Of this region, the most influential area lies just above the mid point of the right page (Livingston, 1978). Though Doerfler does not provide reasoning as to why these areas are more influential, his 'focal point' map has been routinely cited (McVety et al., 2009; NRA, 1994; Ninemeier and Hayes, 2003).

The scanpaths shown in Fig. 1, and focal area shaded in Fig. 2 are prevalent in trade press, though their foundations have not been

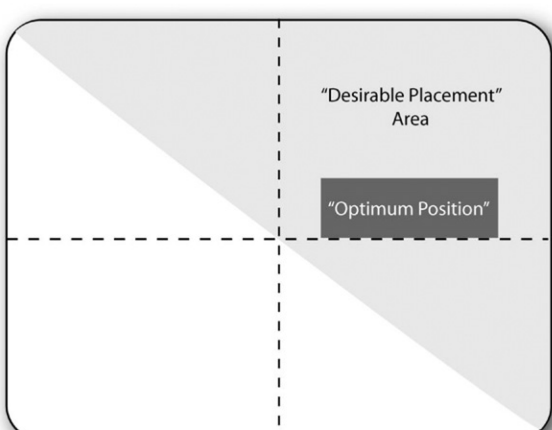

Fig. 2. Two-page menu focal areas (Doerfler).

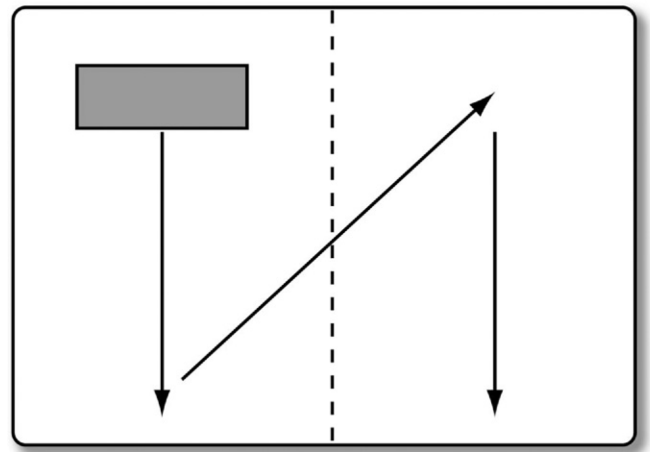

Fig. 3. Two-page scanpath (Gallup report).

empirically proven. The only publicly available gaze motion and eye tracker study published to date was commissioned by the National Restaurant Association and conducted by the Gallup Organization in 1987. The NRA/Gallup study used an infrared pupil/corneal reflection eye tracking system to record subjects' scanpaths, and showed a more book-like reading pattern for two-page menus (Fig. 3) (Gallup, 1987).

Though the Gallup study included general summary statistics on how long guests looked at a variety of menu categories, and tracked the visual sequence subjects followed across a test menu – the study did not disclose the methodology used to determine the aggregated gaze motion sequence profiled in Fig. 3.

1.2. Scanpaths

In general, a scanpath is a series of movements made by the eye as it shifts between fixation points during the viewing of a stimulus. Understanding the scanpath used by consumers to evaluate restaurant menus can provide insight into the information gathering and decision making processes used to make meal choices. The analysis of eye tracker data has been effectively used to evaluate, among other things, consumer attention to advertisements (Pieters and Wedel, 2004; Wedel and Pieters, 2000, 2008), websites (see Pan et al., 2004 for a review), telephone book ads (Lohse, 1997), and traditional print media and online print media (Holmqvist, Holmqvist et al., 2003). The use of eye fixation durations and sequences as a way to evaluate consumer decision making processes is arguably a more detailed and quantitatively valid research method than other methods such as information boards, verbal protocols and input/output analysis (Russo, 1978).

Where and in what order a person looks at when conducting a visual search is influenced by the person's objective(s) for the task at hand (Buswell, 1935; Yarbus, 1965/1967). For example, in a series of classical visual search experiments, Yarbus presented subjects with an illustration of a group of people sitting and standing about a living room. When subjects were given the objective of determining the socio-economic status of the people in the illustration, the resulting scanpath was different from that produced when subjects were asked to speculate about why some of the people in the illustration were standing. When people have different reasons for looking at a stimulus, they will have different scanpaths. To the extent that people have similar objectives for looking at a restaurant menu, they should have similar scanpaths. Thus:

H1: When given the objective of composing a meal, consumer scanpaths across a restaurant menu are (a) comprised of a series of non-random fixations, and (b) are stable across individuals.

The order and duration of fixations within a scanpath should not only vary by the objectives of the task at hand, but they can also vary greatly depending upon the characteristics of the menu being viewed and by the person doing the viewing. Specifically, prior research has shown that the initial search strategy used to evaluate a visual field (and the resultant scanpath that it produces) is likely guided by cognitive models of where the viewer believes relevant information might exist (Fisher et al., 1981; Noton and Stark, 1971). That is to say consumers, knowingly or unknowingly, direct their eye movements to fixation points based on where their past experiences, knowledge, or overall beliefs suggest the most important centers of information might be located. As a result, search scanpaths are more likely to reflect consumer experiences and expectations of where information should be rather than anything about how the image or visual stimulus was actually designed.

Given the typical progression used by most restaurants to list menu categories from lighter to heavier fare, we can imagine consumers becoming accustomed to and building schemes for menus (and perhaps different menu types) and come to expect a typical layout where lighter fare is listed first and heavier foods listed later. In addition, given the physical resemblance of many restaurant menus (two facing-pages) to other reading materials which display two facing-pages at a time such as books or magazines, it is expected that consumers would activate and execute upon a cognitive model reminiscent to that of their normal reading behavior, such as reading a book. For Western societies, reading behavior is expected to start at the top of the left page, progress down the page and continue top-to-bottom on the next (right) page. This book-like gaze motion sequence was observed by Gallup in 1987. As such, H2: Restaurant menu scanpaths will be more similar to those observed in book reading than those espoused by industry literature.

Operationally, H2 is supported if observed scanpaths are more similar to that reported by Gallup in Fig. 3 than that of industry convention shown in Fig. 1.

Confirmation of H1 would empirically demonstrate that given a single objective of ordering off a two-page menu, different consumers will follow a single, non-random scanpath across the menu – that there is an '*average scanpath*' for a typical two-page menu. Confirmation of H2 would empirically validate a book-reading pattern as more representative of how consumers look at a menu than the criss-cross shaped scanpath most prevalent in industry convention today. Finally, the data collected can also be analyzed to determine the whether a design sweet spot exists where guests tend to look at first, last, and or most frequently.

2. Methods

2.1. Participants

A mixed group of 27 graduate, undergraduate and faculty participants was recruited over the course of three weeks through a university-wide, online experiment sign-up service hosted by the psychology department of a large university located in the United States. Participants received either course credit (1 person) or a cash payment of $5 (26 people) to participate in the study in April 2008. All participants were naïve to the purpose of the study, and were recruited only with the knowledge that they would be required to read menus without the use of eye glasses (participants using contact lenses were permitted). Data collected from two subjects could not be used due to poor calibration conditions on the eye tracker apparatus, thus the following analysis is based upon a sample of 25 subjects.

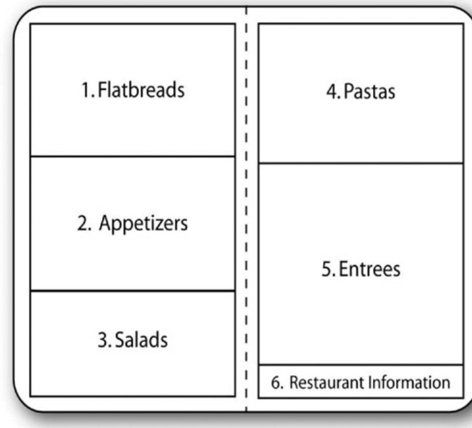

Fig. 4. Map of stimulus menu.

2.2. Apparatus

The study utilized an iScan EC501 infrared pupil/corneal reflection eye tracking system from ISCAN, Inc. to track subject eye movements for the duration of the experiment. The iScan EC501 head mount is comprised of a headband and two cameras – one camera feeds a view of the subject's retinal area to a computer system used to calculate the subject's point of gaze, and a second camera feeds a reflection of the subject's visual field to a NTSC TV and DVR recording system. The combined output of the two cameras is a video recording of each subject's visual field overlaid with crosshairs corresponding to the subject's point of gaze. A running time index, shown in frames per second (fps) was also superimposed on the bottom of each subject's scanpath video. The iScan EC501 recorded data at a rate of 60 fps.

2.3. Stimulus description and region of visual fixation

The stimulus of concern was a two-page, folded menu comprised of two 8.5″ × 11″ facing sheets. Menu items were printed in a black ink in a 12 point san-serif font on a cream colored cardstock. The menu pages were inserted into a laminated cloth hard cover portfolio. The menu was sectioned into six distinct categories as shown in Fig. 4. The stimulus menu was designed to reflect a typical two-page menu, laid out under a progressive format where various lighter, starter fare are presented on the left page, and more substantial fare are offered on the right page.

Although the visual fixation points calculated by the iScan system produces distinct coordinates (corresponding to the approximately two degrees of visual angle to which the fovea is directed), the actual reading-comprehension capable field of vision includes a parafoveal region which extends about five degrees to the left and right of foveal vision.[1] As such, the unit of fixation used in this experiment is of predefined regions (corresponding to the menu categories shown in Fig. 4), and not of distinct point estimates.

[1] A degree of visual angle is approximately equal to 3–4 letters printed in a normal font size, which implies central foveal vision spans 6–8 letters and the parafoveal visual area increases the total viewable area to:

$$(5^\circ + 2^\circ + 5^\circ) \times \frac{4 \text{ letters}}{1^\circ} = \text{Up to 48 letters} \quad (1)$$

There is an even larger peripheral retinal area of approximately 200° horizontally and 130° vertically that responds well to visual stimulus, though image comprehension in these peripheral areas is crude.

2.4. Measurements of interest

For the purposes of this study, two types of data were recorded for each subject: fixation sequence and fixation duration. Fixation sequences were used to evaluate Hypotheses 1 and 2, and fixation durations were used for supplementary analysis on menu "sweet spots," and for theory building on the thought process behind menu reading strategies.

Coding the recorded scanpath videos necessitated defining what length of gaze constitutes a visual fixation. In general, there are two types of eye human eye movements: saccades and fixations. Saccades are very quick and short corrective eye movements that center the fovea onto an area of interest, and information processing is generally suppressed during saccadic movements. Fixations however, are characterized by longer, smoother eye movements, and are highly correlated to intensive cognitive processing (Rayner, 1998). Though there is much debate surrounding what length of gaze constitutes a fixation and not a saccade, many researchers agree that the average fixation length necessary for comprehension is between 100 and 500 ms (Rayner, 1998; Spache, 1962; Yarbus, 1967). More recently, a 200–300 ms gaze aimed at a specific area is generally defined as a fixation, and typical reading fixation lengths are approximately 275 ms in duration (Rayner, 1998). For the purposes of this experiment, a 275 ms threshold was chosen to define a point of fixation.

Fixation sequences were based on fixation regions coded and derived from each subject's scanpath video recording. All fixations that lasted for 275 ms or longer in duration were counted towards a scanpath sequence. The first fixation was defined as the region where the subject's foveal crosshairs first appeared on the menu stimulus. The last fixation was defined as the region where the subject's foveal crosshairs were aimed when the subject was ready to place an order with the experimenter.

Fixation durations were calculated as the time difference between when the foveal crosshairs first entered a menu area (one of the six menu categories), and when the crosshairs exited the menu area. While fixation durations provide information on how long subjects spent on each viewing pass through a menu category, a straight duration metric would be a skewed metric for attention and reading comprehension as menu categories varied in length from 28 words (category six) to 104 words (category five). As such, a reading rate, normalized for menu area word count, was used to evaluate how thoroughly a menu category was read:

$$\frac{\text{Fixation duration (s)}}{\text{Number of words in category}} \times 1000 = \text{Fixation duration (ms/word)} \tag{2}$$

Based on rauding theory,[2] a person can comprehend material using one of five processes: (1) memorization, (2) learning, (3) rauding, (4) skimming, or (5) scanning (Carver, 1992). Which process is used when reading will manifest itself as slower or faster reading speeds. For example, most readers typically default to a rauding process – the fastest rate at which a complete thought could still be extracted from each sentence by looking at consecutive words. In contrast, skimming extracts more general concepts where sentence-level detail is not needed, and scanning is used only to find targeted words. In general, college students raud process at approximately 300 words per minute (wpm) (or 200 ms/word), skim at 450 wpm (133 ms/word), and scan at 600 wpm (100 ms/word) (Ibid.). In summary, three measurements of interest are reported in this study, each measure provides unique insight into how subject looks at and evaluates a menu:

- Fixation sequence and count frequency – each fixation occurrence on the menu was recorded in a sequence of fixations to create a scanpath, and identifies the order in which the subject reads the menu. The fixation sequence is needed to evaluate the first, last, points of fixation on the menu. Fixation count by menu area was recorded to evaluate the area most frequently viewed by participants. Each fixation was at least 275 ms in length.
- Fixation duration – a time metric used to account for the length of time a participant spent viewing an area of the menu. This metric was used in the Gallup (1987) study, and is used in the eye movement literature to define whether stimulus has been absorbed or processed by the reader. Fixation duration is presented in milliseconds per fixation.
- Reading rate – a word count adjusted duration metric that is used to evaluate whether or how well text has been read. Reading rates are presented in words per minute (wpm), and are widely used in the reading comprehension literature.

2.5. Procedures

Upon arrival, each participant was introduced to the eye tracker headband they would wear for the duration of the trial. After donning the eye tracking apparatus, participants were asked to adjust their seating so that the image of a $2.5' \times 2.5'$ calibration grid would be fully visible in the data output monitors. This seating adjustment typically resulted in subjects being seated approximately 150 cm away from the calibration grid. Calibration of the iScan head mount required the participants to hold their head still; however no bite bar or chin rest was used to stabilize the head in order to provide a more naturalistic viewing environment. The calibration phase of the experiment required the participant to look at a series of fixed points on the calibration grid. The experimenter then calibrated the iScan system's video crosshairs to match up with the participant's actual point of gaze. Although a minimum of three calibration points is required to calculate a participant's point of gaze, this experiment calibrated each participant's gaze to nine separate calibration points.

After calibration, each participant was asked to view a series of three menus: two wines lists and one dinner menu. Only the scanpaths of the dinner menu are used for this study. For the menu viewing, participants were instructed to look over and order a meal off the menu as if they were in a normal restaurant. They were told to order as much or as little as they desired, but to compose a meal that they would order if the menu were presented to them in a real restaurant. If they had any questions about the menu or any of the items listed, they were to treat the experimenter as their table server. Similarly, when they were ready to 'order,' they should signal the experimenter and place the order. From introduction to calibration to food order placement, trials lasted an average of 17 min, with the longest trial lasting 29 min. Video recorded observations were manually coded as a series of menu category fixations based on the menu categories listed in Fig. 4.

2.6. Sequence similarity

An optimal matching analysis (OMA) can be used to determine the degree of similarity between sequences. OMA generally refers to sequence comparison techniques and often uses various metrics to measure (dis)similarity. The OMA used in this study relies upon Levenshtein distances calculated between each observed sequence and the Gallup sequence, and the distances between

[2] Rauding is word derived from the combination of 'reading' and 'auding,' and refers to the assumption that reading thought comprehension utilizes the same underlying process as auditory learning. When people comprehend complete thoughts, they are considered to be rauding (Carver, 1992).

Menu Area	Total Fixations	Fixation Duration (sec)		Fixation Duration/Word (ms)		Fixations per Person		
		Mean	StDev	Mean	StDev	Median	Mode	Mean
1	47	21.7	19.8	434.1	396.4	2	2	1.9
2	50	24.7	18.3	385.9	286.6	2	2	2.0
3	27	18.9	14.3	394.4	297.2	1	1	1.2
4	46	26.6	20.3	345.1	264.3	2	2	1.7
5	51	42.6	36.5	409.3	350.8	2	2	1.8
6	9	5.1	3.0	183.0	108.5	0	0	0.3
Entire Menu		238.7	82.3	385.8	320.5	9	8	0.0

Fig. 5. Summary statistics of menu area fixation measures.

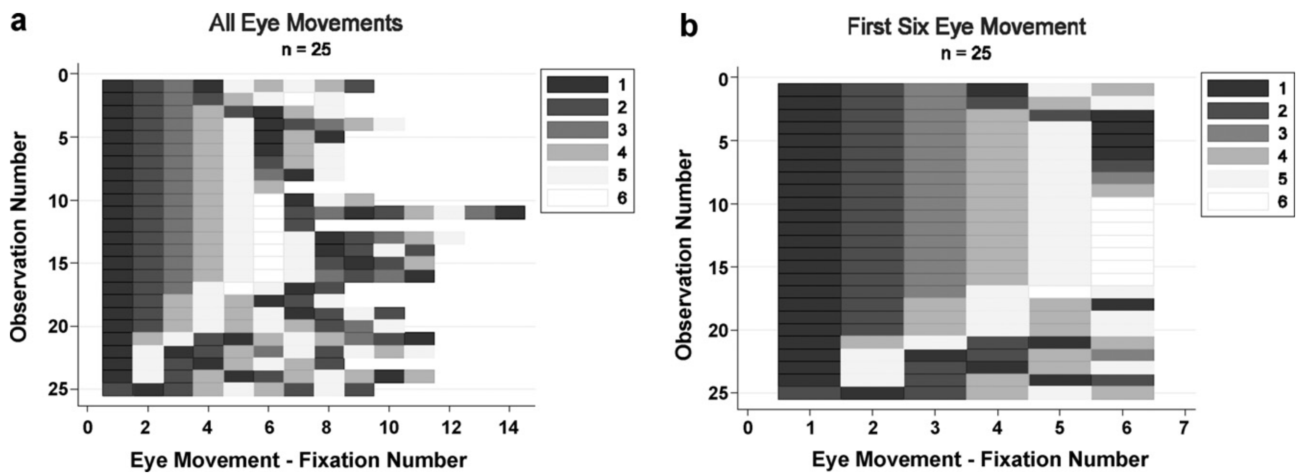

Fig. 6. Eye movement sequence by menu area.

	Sequence Through Eye Movement Number								
	1	2	3	4	5	6	7	8	All
Sequences Possible	6	36	216	1,296	7,776	46,656	279,936	1,679,616	7.8E+10
Unique Seqs. Observed	2	4	6	10	11	16	20	24	25
Occurance of Most Common Seq.: # (%)	24 (96%)	20 (80%)	17 (68%)	14 (56%)	13 (52%)	7 (28%)	4 (16%)	2 (8%)	-
p(Any Single Unique Sequence)	0.167	0.028	0.0046	0.0008	0.0001	0.00002	3.57E-06	5.95E-07	1.28E-11
p(# of Most Popular Sequence Observed)	1.76E-19	6.50E-32	1.99E-40	2.63E-44	2.63E-51	2.08E-33	1.63E-22	3.54E-13	-
Most Common Sequence	1	1-2	1-2-3	1-2-3-4	1-2-3-4-5	1-2-3-4-5-6	1-2-3-4-5-6-5	1-2-3-4-5-6-5-1	-

Fig. 7. Sequence probability summary.

each observed sequence and that of Industry convention.[3] A Levenshtein distance is a count of how many insertions and deletions are needed to transform one sequence into another and is frequently used in spell-checking, DNA and gene sequencing, and speech pattern recognition tasks (Levenshtein, 1966). Smaller Levenshtein distances signal greater similarity between sequences and longer distances imply greater dissimilarity between sequences. Ostensibly, the sequence that minimizes the distance between all observed sequences can be considered the most representative or 'average' sequence. This study used the SQ-Ados for Stata suite to compute standardized[4] Levenshtein distances and conduct an optimal matching analysis (Brzinsky-Fay et al., 2006).

3. Results

A summary of the fixation durations observed is listed in Fig. 5. Based on data from 25 participants, the mean sequence duration lasted 239 s with a standard deviation of 82 s (4.0 and 1.4 min, respectively). The average fixation duration for any one area on the menu was 386 ms/word (approximately 155 wpm), and indicative of learning focused reading but slower than traditional rauding. This speed implies subjects took their time to learn the menu, not just to skim or scan, or to memorize its content. In general, subjects returned their gaze to areas 1, 2, 4 and 5 of the menu as evidenced by the greater than 1 count on the average, median and mode fixations for those respective sections. On average, participants made 9.2 category fixations before choosing to place an order.

Because menu area 6 only garnered nine fixations across all 25 subjects, and because the area contained no relevant choice information, unless otherwise noted the remaining statistical analysis reported will focus on menu areas 1–5. Total fixations by menu area revealed significant differences between the number of fixations made between areas 1 through 5 ($F_{4,120} = 4.10$, $p = 0.004$). An ANOVA contrast revealed that the number of fixations in menu area 3 was significantly lower that of areas 1, 2, 4, and 5 ($F_{1,96} = 342$, $p < 0.001$). A second ANOVA conducted between total fixations by menu area for the remaining areas (1, 2, 4, and 5) revealed no further significant differences between menu areas ($F_{3,96} = 0.97$, $p = 0.413$). These results suggest that no particular frequency-based sweet spot on the menu exists as no one area is more frequented than any other, however a 'sour spot' may exist as fewer fixations were made in menu area 3.

[3] Based on the menu areas on the experiment menu (Fig. 4), the Gallup menu category fixation sequence is 1–2–3–4–5–6, and the industry menu category fixation sequence is 5–4–1–2–3–5.

[4] When comparing sequences of different lengths, raw distance calculations are heavily influenced by the disparity in sequence lengths. Standardizing distance eliminates this bias. Distances within an analysis are standardized by dividing a raw distance score by the length of the longest sequence in the dataset.

A visual summary of gaze sequence data by participant is presented in Fig. 6(a and b), where each participant is represented as a row of color-coded eye movements within each table. Fig. 6a shows the entire data set, where participant #11 had the longest eye movement sequence of 14 fixation points, and participant #9 had the shortest movement sequence at just six fixations. Each subject had a unique fixation sequence. However as the analyzed sequence length was shortened, the number of subjects with the same fixation sequence began to converge. For example at a sequence length of eight fixations, 24 unique sequences were observed and two of the 25 subjects followed the same fixation sequence. The probability of observing any single specific eight-fixation sequence is the binomial shown in Eq. (3):

$$\frac{1}{6^8} = 5.9 \times 10^{-7} \quad (3)$$

The probability of observing two occurrences of the same eight-fixation sequence out of our sample size of 25 subjects was calculated as a binomial probability (4):

$$\binom{25}{2} (5.9 \times 10^{-7})^2 (1 - 5.9 \times 10^{-7})^{23} = 3.54 \times 10^{-13} \quad (4)$$

Fig. 7 details the observed and expected frequencies and probabilities of various sequence lengths. The greatest improvement in sequence consolidation occurs when sequence size is limited from six fixation points to five. At a five-fixation sequence cut-off, the binomial probability of observing any single unique sequence is less than 0.00013, yet 13 of 25 subjects (52% of observations) followed the same 1–2–3–4–5 sequence. If restaurant menu eye movement sequences were purely random, the probability of observing 13 of 25 subjects with the same five-fixation sequence would be 2.63×10^{-51}. The difference between the observed 52% convergence and the 2.63×10^{-51} expected probability of such a convergence provides good evidence in support of H1a – that eye movement are *not* a series of random fixations.

Support for H1b however is not as clear. While all participants made at least six fixations, the average number of fixations made per person was just over nine. And while sequence convergence was not statistically significant when full sequence lengths were compared against the two benchmark sequences (Industry and Gallup), observations did converge across individuals when sequences were shortened to six movements or less. Because subjects were encouraged to take their time in the 'ordering process,' many made more than one viewing pass across menu categories before making a decision (Fig. 9). Prior research on gaze motion as a tool for choice analysis indicates that tail ends of full gaze motion sequences typically reflect elements of consumer uncertainty and indecision as the gaze darts between final options (Russo and Rosen, 1975). As such, limiting the visual scanpath analysis to five or six fixations may be a better representation of how consumers initially scan and read the menu, and reflect how subjects conduct their initial read when presented with a menu.

Levenshtein distances were calculated between all 25 observed sequences. The observed sequence with the shortest Levenshtein distance to all other sequences (1–2–3–4–5–4) is interpreted to be the 'average' sequence as it minimizes the distance between all other sequences, and is shown in Fig. 8. The average sequence does not include a fixation on menu category six where information about the restaurant and chef was listed. It is reasonable to assume, given the size and proximity of category six to the end of the entrée section, that subjects could glean enough information using parafoveal vision to deduce that the section did not contain food items or information directly relevant to the decision at hand. In other words, subjects likely perceived through peripheral vision that there was nothing relevant in category six and decided not to fixate on that part of the menu.

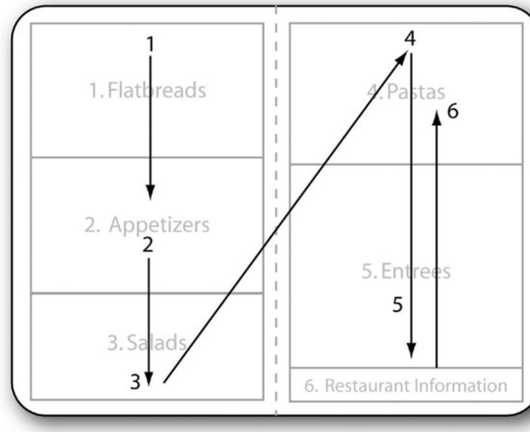

Fig. 8. Average gaze motion sequence by menu area.

A paired t-test was conducted to compare the distances between each observed sequence and the Gallup sequence and then between each observed sequence and the Industry espoused sequence. The mean Levenshtein distance between observed and Gallup sequences was 0.377 and 0.523 between observed and Industry sequences ($t_{24} = -6.62$; $p < 0.0001$). Comparisons against the Gallup sequence produced significantly smaller Levenshtein distances than comparisons against the Industry espoused sequence. The Gallup sequence was more representative of actual observations than the industry espoused sequence. Thus H2 is supported in that consumer scanpaths are more similar to the Gallup sequence – consumer eye movements on a menu follow a more book-like reading pattern.

These results suggest consumers make their initial scans of a menu in a relatively consistent manner – they read a menu much like they read a book. The typical scanpath starts on the top of the left page, works its way down to the end of the first page, moves to the top of the second page, and follow the same top-down reading pattern. This 'average' scanpath is consistent with that previously reported by Gallup in 1987, but is now presented with quantitative support: it is the scanpath that is most similar to those observed in this experiment. The 'average' sequence upon which this pattern is based, is relatively short – it is only six fixations in duration whereas participants averaged approximately nine fixations before placing their orders. This disparity in sequence length leads to two questions: (1) are subjects making two separate passes for two different purposes – perhaps an initial scan to get a handle on where information might be and then a more deliberate, detailed reading, and (2) what happens with the last three or four fixations when people start to deviate from the average pattern?

Since each menu area varies in word length, a metric of fixation duration per word was used to evaluate subject reading speed. The shorter the fixation duration per word, the faster the speed, and presumably, the lower the reading comprehension and information retention. In general, highly efficient readers can comprehend via fixations at a rate of 200–250 ms per eight character string and any single reader typically comprehends information at a rate of approximately 100–500 ms per word (Rayner, 1998). To determine whether subjects first scan and then read the menu, fixation durations per word for each menu area were compared to durations for each subsequent viewing (Fig. 9). Over all, first-round passes of all menu areas appear to have been fully read as their average fixation duration was 340 ms/word or longer. This speed corresponds to rauding and learning speeds where readers general comprehend complete thoughts in sentences and retain enough information to be able to pass a multiple choice test (Carver, 1992). Menu area 6,

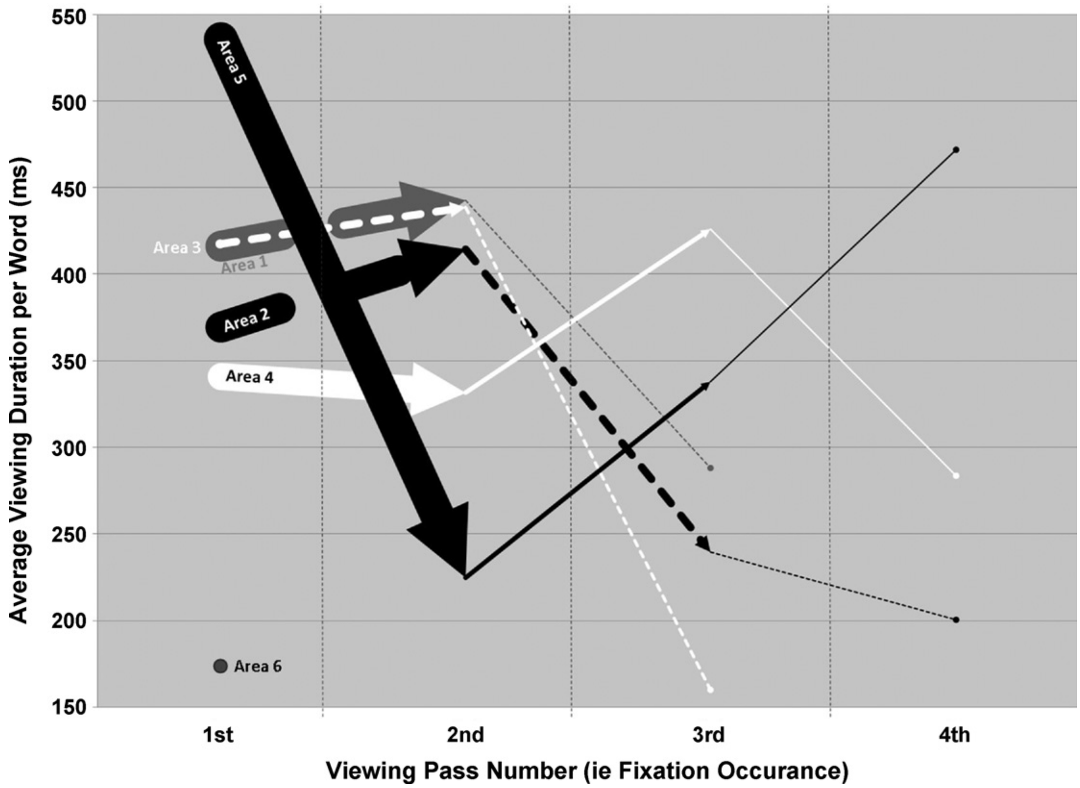

Fig. 9. Average viewing duration progression by menu area (ms). NOTE: Line thicknesses are proportional to the number of observations per viewing. For example, the number of observations for menu area 1 were 25 on the first pass, 19 on the second, and 2 on the third pass, and no subjects made a fourth pass. Dotted lines indicate menu areas on the first page, and solid lines indicate menu areas on the second page.

with an average fixation duration of approximately 174 ms/word, seemed only to be skimmed for meaning.

In general, most subjects only made two passes of each section on the menu. As shown in Fig. 9, the most frequently revisited sections of the menu were areas 2, 4 and 5, but progressively fewer subjects made second, third and fourth passes to those menu sections. Most notable in Fig. 9, average reading time for menu area 5 (Entrées) was significantly lower on the second viewing pass than it was on the first time around ($F_{1,24} = 8.58$, $p < 0.01$). More specifically, as shown in Fig. 10, the average entrée section reading rate between viewing passes one and two increased from 112 wpm to 266 wpm (536 ms/word to 225 ms/word). These speeds suggest subjects were reading to memorize the entrées on the first pass, and then rauding or skimming on the second pass. No other significant differences between first and second pass read rates were found for other menu areas. The ANOVA also revealed a significant difference in fixation duration lengths for menu area 1 ($F_{2,24} = 4.24$; $p < 0.05$), however further analysis shows the difference is the result of a lower fixation duration on the third pass. ANOVA contrasts of menu area 1 fixation durations show no significant difference between passes one and two ($F_{1,20} = 1.22$), or pass two and three ($F_{1,20} = 2.26$).

When fixation durations between first and second round viewing passes were compared, there was no significant difference between average fixation duration for menu categories listed on the first page (categories one, two and three: flatbreads, appetizers, and salads) ($t_{110} = 0.02$; $p > 0.98$). Fixation duration *decreased* for menu categories on the second page (categories four and five: pastas and entrees) ($t_{95} = 2.15$; $p < 0.05$). It appears that all food options are read on the first pass, but that the entrées are most carefully evaluated on the first pass. These findings, along with the information presented in Fig. 9, seem to suggest that the consumer first conducts a slightly faster read of the lighter fare, then conducts a more thorough read through of the entrées, chooses an entrée, and then proceeds to build a meal around the entrée.

4. Discussion

Based on industry application of the rules of recency and primacy, it seems that what industry considers as the design 'sweet spot' should be more carefully parsed. There does not seem to be one particular spot on the menu where a person tends to look at first, last, and most frequently. If the sweet spot is considered to be where the guest looks to first, then the sweet spot is in the upper left corner of the first page. However, if the sweet spot is considered to be where the guest looks to last or most recently, then based upon the data gathered there does not seem to be a recency-based sweet spot. Finally, if the sweet spot is the area which is most frequently viewed, then yet again there is no clear sweet spot as the mean number of fixations per single menu area per person is not statistically different between any of the menu areas that offer item choices (areas 1–5). Only the bottom area of the each page (areas 3 and 6) exhibited statistically significant *fewer* fixations than other areas of the menu. So perhaps there are 'sour spots' on the menu where guests tend not to focus their attention. It is unclear however, whether the statistically fewer fixations were due to the menu area placements or the content within those areas. It is very possible that subjects tended to gloss-over the restaurant information (area 6) and salads (area 3) simply because they were uninteresting or not relevant to their individual decision making criteria. Further research should explore whether menu area location popularity is affected by menu content.

Initial readings of the menu tend to follow a book reading pattern, and they tended to end where the relevant information ended, in this case where the entrées ended towards then bottom of the

Menu Area	Fixation Duration/Word (ms)					
	By Viewing Pass				Duration Contrast by Pass	
	1st	2nd	3rd	ANOVA	1st/2nd	2nd/3rd
1	416	442	288	$F_{2,24}=4.24^{*}$	$F_{1,20}=1.22$	$F_{1,20}=2.26$
2	370	415	240	$F_{2,24}=1.03$	$F_{1,22}=1.33$	$F_{1,22}=20.48^{***}$
3	417	439	160	$F_{2,19}=0.99$	$F_{1,19}=0.62$	$F_{1,4}=5.48$
4	341	332	426	$F_{2,23}=0.07$	$F_{1,19}=1.25$	$F_{1,19}=11.74^{***}$
5	536	225	338	$F_{2,24}=4.65^{**}$	$F_{1,24}=8.58^{***}$	$F_{1,19}=13.85^{**}$
6	174	-	-	-	-	-
Page 1	396	395	532	$F_{2,120}=0.83$	$t_{110}=0.02$	$t_{51}=1.04$
Page 2	414	283	368	$F_{2,101}=2.15$	$t_{95}=2.04^{*}$	$t_{44}=1.03$

* Significant at $p<0.05$; ** Significant at $p<0.02$; *** Significant at $p<0.01$

Fig. 10. Viewing duration per word by menu area summary.

right page. The gaze motion or scanpaths however, for the most part continued after an initial reading of the menu, and likely reflect the guest re-reading parts of the menu and flitting the gaze between final choice alternatives. Based on the findings from this study, practitioners should approach traditional menu design explanations with a skeptical eye – consumers read a typical two-page menu like a book, and likely build their meals around a chosen entrée. It is worthy to note that this study only tracked subject eye movements, and did not delve into why subjects made the eye movements they made. Although guests did show longer periods of fixation on menu items they ultimately ordered, it is unclear whether this was a cause or effect. That is to say it is unclear from the data whether increased fixation on a menu item is a result of having selected an item, or whether it can be a predictor of the likelihood an item will be ordered.

It is also important to note that this study only examined consumer eye motion and reading patterns on a two page menu. While the two page, 8.5″ × 11″ menu format is a widely used layout for restaurants (Pavesic, 2011), there is a wide variety of custom-print menu formats in popular use today. Industry conjecture has put forth eye motion scan paths for single page, two facing-pages, and three-page fold-out styles of menus. Future research should also examine whether traditional industry 'wisdom' for single and three-page fold out menus are accurate. The results of this study suggest there may be reason to re-think how consumers read their restaurant menu options.

Though there may be psychological principles behind current menu design practices, design principles as applied to restaurant menus have not been empirically proven to increase purchase intention, actual sales, or even attention (Bowen and Morris, 1995; Gallup Report, 1987; Kincaid and Corsun, 2003; Reynolds et al., 2005). It is not clear whether the ineffectualness of design tactics to produce changes in sales is due to a breakdown between design and attention or attention and purchase behavior. Previous eye-tracking research on other consumer products suggests that increased attention leads to increased purchase likelihood only for items that are not likely to be remembered (Barber and Odean, 2008; Chandon et al., 2000, 2006). Within the framework of a restaurant menu, customers are rarely expected to memorize or blindly recall and choose items presented on the menu[5] – which begs the question: are attention and memory focused tactics really relevant to increasing purchase likelihood when it comes to menu design? This study examines how consumers look at and evaluate a menu, but does not delve into the deeper discussion of whether gaze motion, fixation sequence, viewing frequency, or increased attention affect menu item memorability or purchase behavior. Whether purchase behavior is affected by design tactics is a matter for future research. This study only goes so far as to say that based on a standard two-page menu layout, there is no one recency or frequency-based design sweet spot, and consumers tend to read a menu like they read two facing book pages of text. Perhaps preference determines choice only after attention has narrowed the number of options. The difficulty with restaurants, however, is that rarely are there so many choice options that attention must be used as a memory device for hidden choice options. That being said, the constructs between design, attention, preference and purchase behavior with restaurant menus are at best imperfect, and there is enough evidence within the marketing literature to suggest that attention does not preclude preference or purchase of any consumer good (Vakratsas and Ambler, 1999).

Though it is important to know how and where consumers look when reading a menu, however, the ultimate goal of the restaurateur and practitioner is to translate knowledge of viewing patterns and gaze motions into increased sales. Menu typography has been shown to increase restaurant average checks (Yang et al., 2009), however no such sales increase has been empirically supported using full layout, design, or attention garnering manipulations. Future research projects should also vary entire menu category locations or employ various attention gathering tactics, and then measure (through point of sales and menu mix data) whether guests are more likely to actually purchase the items they attend to more or those that they see first, last or more frequently.

[5] A notable exception to the need for menu item memorability is when menu items and specials are delivered verbally to the guest by a service person.

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