
LAST BUT NOT LEAST

Points of view: Where do we look when we watch TV?

S Adam Brasel, James Gips

Carroll School of Management, Boston College, Chestnut Hill, MA 02467, USA;
e-mail: brasels@bc.edu

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Abstract. How is our gaze dispersed across the screen when watching television? An exploratory eyetracker study with a custom-designed show indicated a very strong center-of-screen bias with gaze points following a roughly normal distribution peaked near screen center. Examining the show across time revealed that people were rarely all looking at the same location, and the amount of gaze dispersion within frames was highly variable. Different forms of programming yielded different levels of dispersion: static network ‘bumpers’ created the tightest visual groupings, and gaze dispersion for frames with show content was less than the dispersion for commercials. Advertising frames with brand logos generated higher dispersion than the non-branded advertisement portions, and repeated advertisements generated higher dispersion than their first-run counterparts.

The average American spends over 4 hours a day watching television (The Nielsen Company 2008), but do we really know where people are looking when they watch? What is the shape of gaze distribution across the screen? Compared to still images or abstract search tasks, the perceptual process underlying television media consumption has been little explored (Anderson et al 2006). Given identical content do we all look near the same place? There is a need for work that explores the degree of visual heterogeneity across individuals (Goldstein et al 2007) and how different types of show content can create different levels of gaze dispersion.

To investigate, we created a 24-minute television show featuring 13 minutes of show content and 11 minutes of advertising content. We used scenes from the BBC/Discovery nature special *Blue Planet* for show content; footage featured natural scenes of sea life and varied in motion and intensity. Five commercial breaks were inserted into the show with 17 commercials recorded from primetime television; six advertisements (ads) were repeated to explore the effects of visual repetition. Network bumpers (relatively static images of the network logo) were inserted at the beginning of the show and at the end of commercial breaks. The show was coded frame-by-frame for content (show/bumper/ad), and the presence or absence of branding, such as packaging or logos, was noted for each advertising frame.

Nine participants watched the show individually on a 1024 × 768 pixel resolution monitor while being recorded on an ASL 6000 eyetracker system. The eyetracker uses corneal reflection to record point-of-gaze (in x, y coordinates) at 60 frames s^{-1} and is accurate to roughly 0.5° . Because the show was presented at 30 frames s^{-1} , we sampled the eye gaze data at that rate for analysis.

So, where are people looking when they watch TV? Examining the overall pattern of gaze points across the show we see an extremely strong center-of-screen bias (see figure 1). The overall distribution resembles a normal distribution both vertically and horizontally, and highlights how few gaze points occur near the screen edges. Center-of-gaze is $x = 515$ pixels, $y = 364$ pixels, only 3 pixels right and 20 above the actual center of the monitor, with a gaze point standard deviation of only 131 pixels for x and 108 pixels for y . An area covering only 5.97% of the screen encompasses 50% of total gaze points; 90% of gaze points are contained in less than 27% of the screen area.

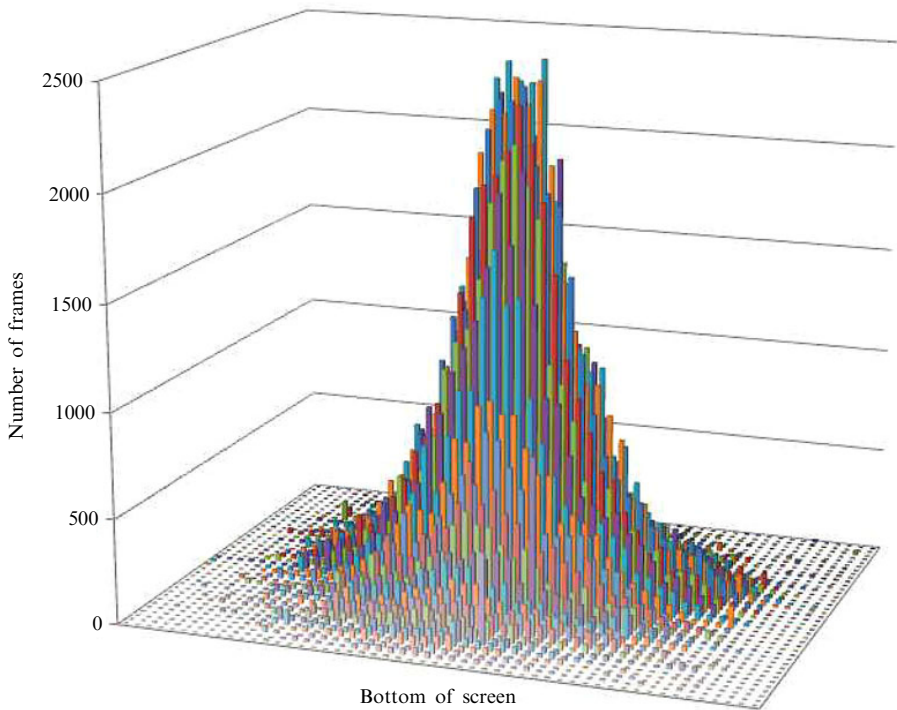


Figure 1. [In color online, see <http://dx.doi.org/10.1068/p6253>] Histogram of gaze points by location on screen.

So the overall gaze distribution shows a strong center-of-screen bias and is roughly normal. This could be due to innate perceptual biases towards screen center combined with content-driven factors such as directors placing elements of importance near the center (Tosi et al 1997). Future work might explore the relative importance of these two potential drivers of central bias.

Given this normal pattern of gaze points overall, for any given frame are people looking at the same place? To measure the variability in gaze location across participants, we calculated the bivariate contour ellipse area (BCEA—Crossland and Rubin 2002) for each frame. BCEA (all values given here are in pixels²) computes a normalized ellipsoidal area indicating how concentrated (small values) or dispersed (large values) the participants' gaze points are across the screen for that frame. See figure 2 for four sample frames with gaze point dispersion.

Plotting BCEA frame by frame (see figure 3) reveals that there is considerable heterogeneity across time, and participants' gaze dispersion within a frame ranges from tightly clustered to widely dispersed (BCEA: min = 1498, max = 601 886, mean = 62 700, SD = 48 736, see figure 4). Clearly, large amounts of gaze dispersion can occur when people are presented with identical content. Although there is a small but significant positive correlation between BCEA and time (Pearson's $r = 0.198$, $p < 0.001$), dispersion varies widely across show presentation.

So, when examined frame by frame, gaze dispersion varies widely even though gaze location overall appears normally distributed from screen center. Can the different types of show content explain some of the differences in gaze-point dispersion? We found an interesting pattern when comparing the mean BCEA for each category of programming (see table 1). First, the tightest focus occurs on frames containing the bumper; as the bumper is a singular piece of information isolated on the screen, tighter dispersion might be expected. When contrasts are run on the log-normalized

BCEA values (normalized owing to extreme positive skew in BCEA), show content has significantly higher dispersion than the bumper ($t_{527} = 17.623$, $p < 0.001$), and ad content has significantly higher dispersion than show content ($t_{34563} = 17.45$, $p < 0.001$ for $ad_{overall}$; $t_{19447} = 4.07$, $p < 0.001$ for show versus $ad_{no\ brand}$, $t_{9897} = 43.56$, $p < 0.001$ for show versus ad_{brand}). Looking within the ads, frames with branding have significantly higher dispersion than frames without branding ($t_{14927} = 39.94$, $p < 0.001$). This could be due to the frequent presence of text in branded frames encouraging more scanpath movement.

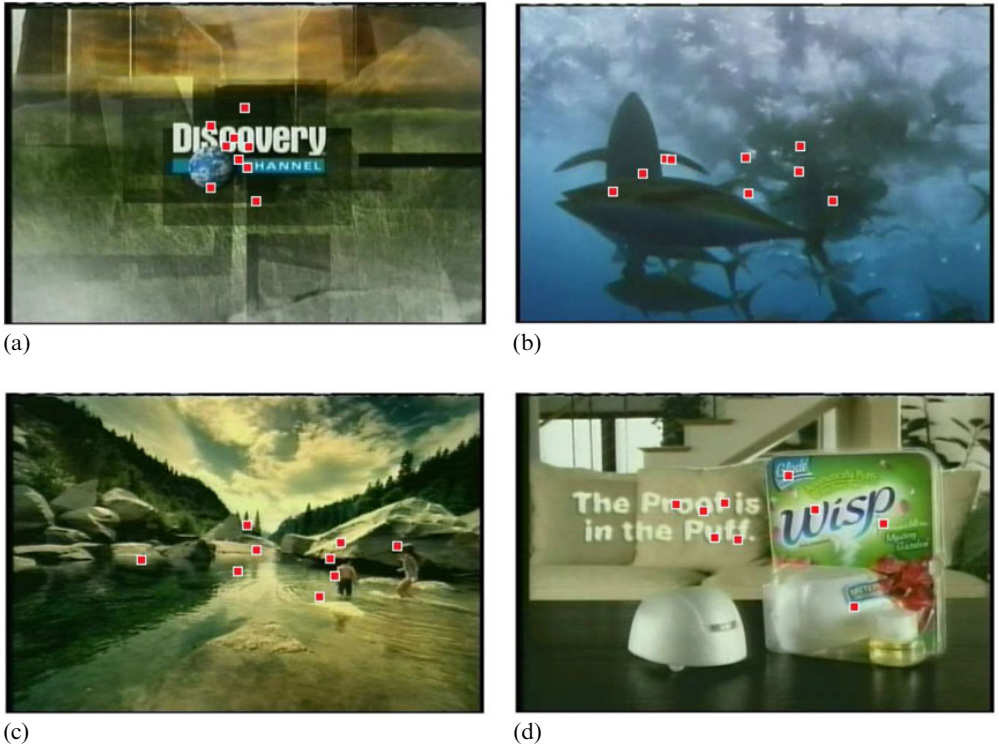


Figure 2. [In color online] Sample frames with marked gaze points. (a) Bumper at 2.5 s, BCEA = 18 866. (b) Show at 305.933 s, BCEA = 55 300. (c) Non-branded ad at 239.8 s, BCEA = 61 499. (d) Branded ad at 203.067 s, BCEA = 94 670.

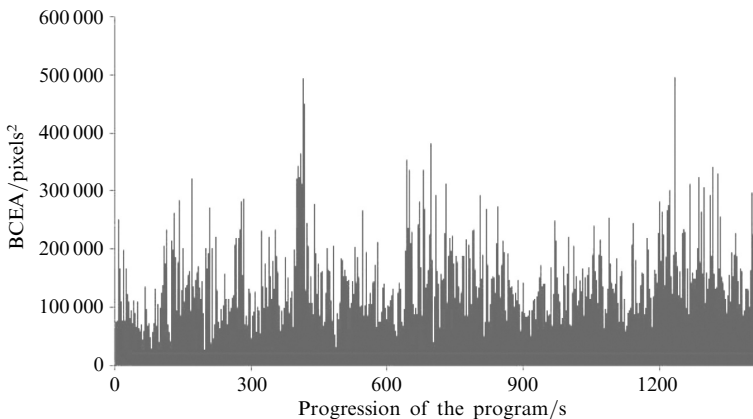


Figure 3. BCEA over time (graphed every 0.1 s).

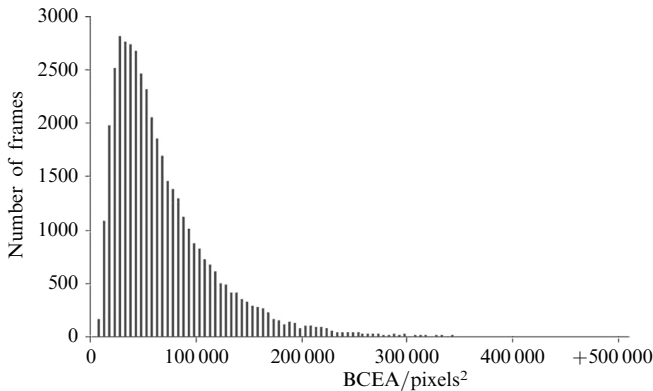


Figure 4. BCEA values histogram.

Table 1. BCEA by show content.

	Bumper	Black	Show	Ad	
				no brand	brand
Mean BCEA across frames/pixels ²	33 029	57 942	56 781	61 210	89 752
Total number of frames	510	678	23 371	11 553	6 429

Does familiarity affect dispersion? When repeated ads are compared against their first-run counterparts, BCEA is significantly higher for the repeated ads (72 661 versus 67 469; $t_{7763} = 3.36$, $p < 0.001$). Might lack of engagement with repeat ads lead participants' eyes to wander? Future work might explore whether this effect replicates across all television stimuli, or if the 'unwanted' nature of advertising drives increased visual dispersion on repeat exposures.

While this overall pattern of results provides an initial exploration into gaze distribution on moving media, it is important to note that we used a single show with a limited number of ads. This suggests that further work is needed to explore the generalizability beyond the stimulus employed, and build on this work to explore more causal drivers of gaze dispersion variation.

In conclusion, the distribution of gaze-point locations for a group of participants watching a television show looks highly normal and centered on the screen. This central bias echoes earlier work (Tatler et al 2005; Le Meur et al 2007) exploring static images or artificial visual-search tasks. When the show is analyzed by frames, wide variances in gaze dispersion are apparent and there is considerable visual heterogeneity across subjects. The pattern of visual dispersion among subjects across time is not completely random, however. First, dispersion grows slowly with time. Second, dispersion is lowest when the static network bumpers are on the screen. Third, show content exhibits lower dispersion than advertising content. Fourth, the portions of commercials with branding elements show higher visual dispersion than the non-branded portions. Finally, repeats of previously shown ads exhibit greater dispersion than their first exposure. The results show how gaze on television programming may be strongly biased towards screen center but gaze dispersion can vary across types of show content.

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