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

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Abstract:

How is our gaze dispersed across the screen when watching television? An exploratory eyetracker study using a custom-designed show indicated a very strong center-of-screen bias with gazepoints 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 ad portions, and repeated ads generated higher dispersion than their first-run counterparts.

Article:

The average American spends over four 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, comparatively little research has explored the perceptual process underlying television media consumption (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, Woods, and Peli 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 thirteen minutes of show content and eleven minutes of advertising content. We utilized 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 using seventeen commercials recorded from primetime television; six 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 resolution monitor while being recorded on an ASL 6000 eyetracker system. The eyetracker uses corneal reflection to record point-of-gaze (in X, Y) at 60 frames per second and is accurate to roughly 0.5 visual degree. Because the show was presented at 30 frames per second, we sampled the eyegaze data at that rate for analysis.

So where are people looking when they watch TV? Examining the overall pattern of gazepoints 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 gazepoints occur near the screen edges. Center-of-gaze is X = 515, Y=364, only 3 pixels right and 20 above the actual center of the monitor, with a gazepoint standard deviation of only 131 for X and 108 for Y. An area covering only 5.97% of the screen encompasses 50% of total gazepoints; 90% of gazepoints are contained in less than 27% of the screen area.

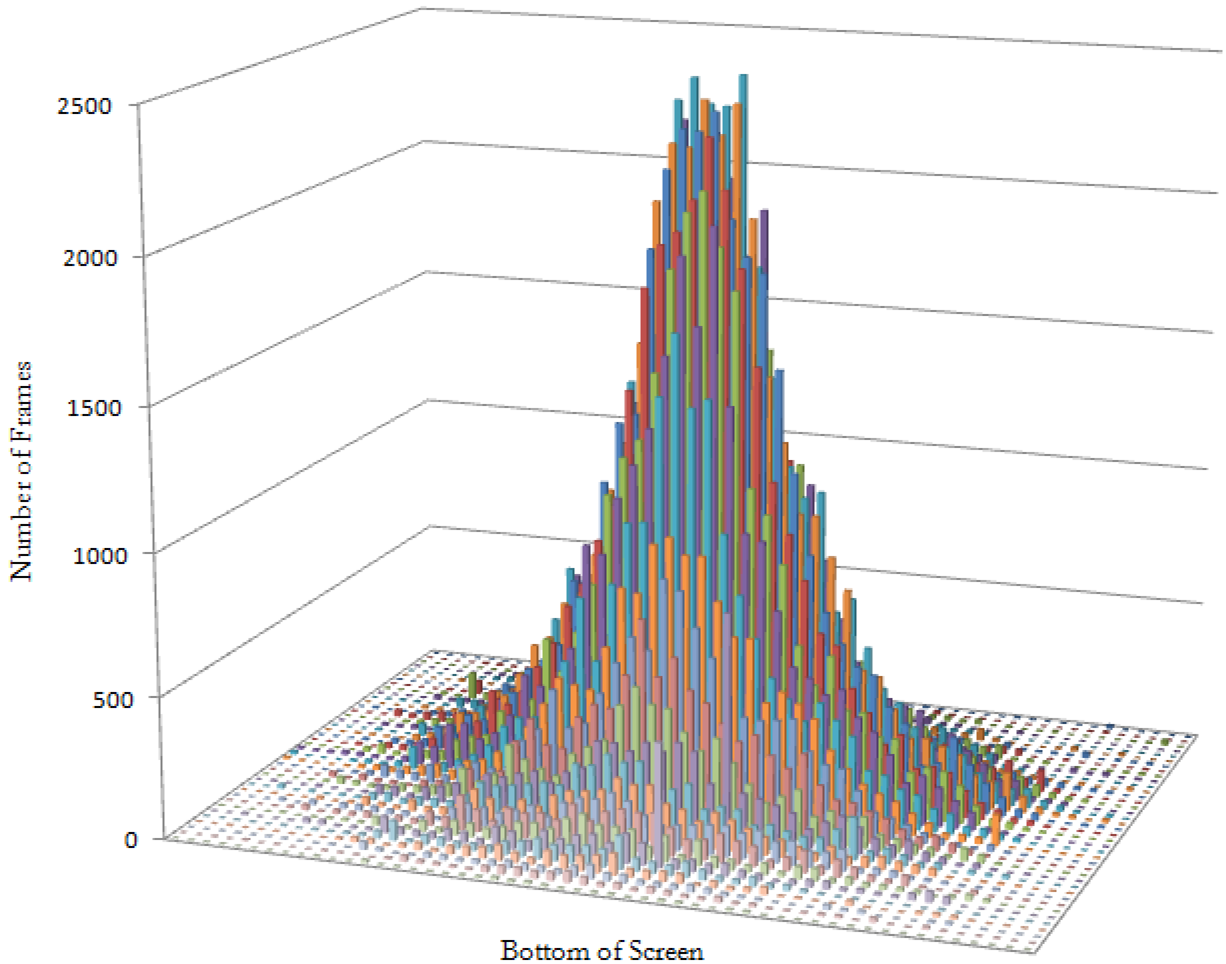

Figure 1: Histogram of gazepoints by location on screen.

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, Mecacci, and Pasquale 1997). Future work might explore the relative importance of these two potential drivers of central bias.

Given this normal pattern of gazepoints 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 computes a normalized ellipsoidal area indicating how concentrated (small values) or dispersed (large values) the participants' gazepoints are across the screen for that frame. See Figure 2 for four sample frames with gazepoint dispersions.

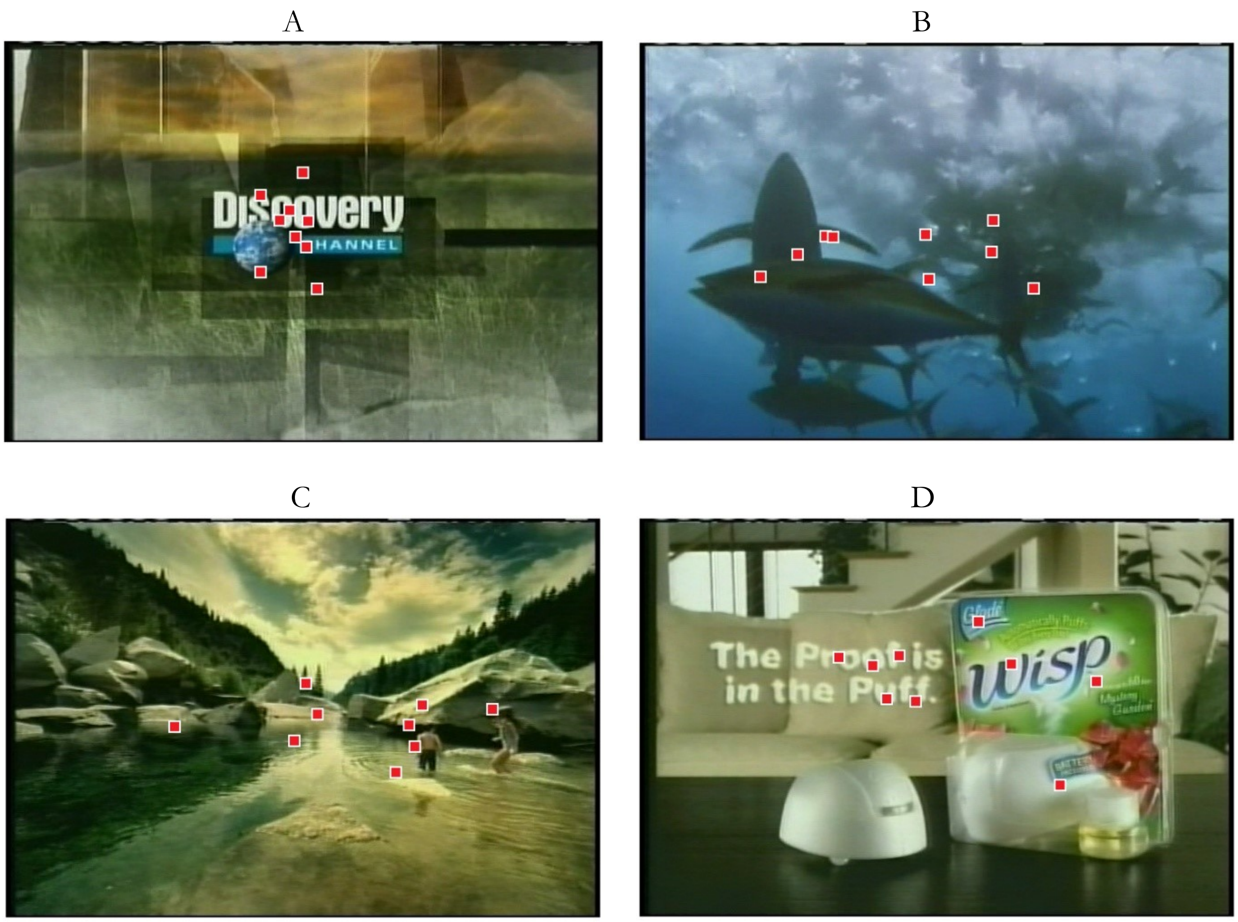

Figure 2: Sample frames with marked gazepoints. A: Bumper at 2.5 seconds, BCEA = 18,866. B: Show at 305.933 seconds, BCEA = 55,300. C: Non-Branded Ad at 239.8 seconds, BCEA = 61,499. D: Branded Ad at 203.067 seconds, BCEA = 94,670.

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 = 1,498, 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 $r = .198$, $p < .001$), dispersion varies widely across show presentation.

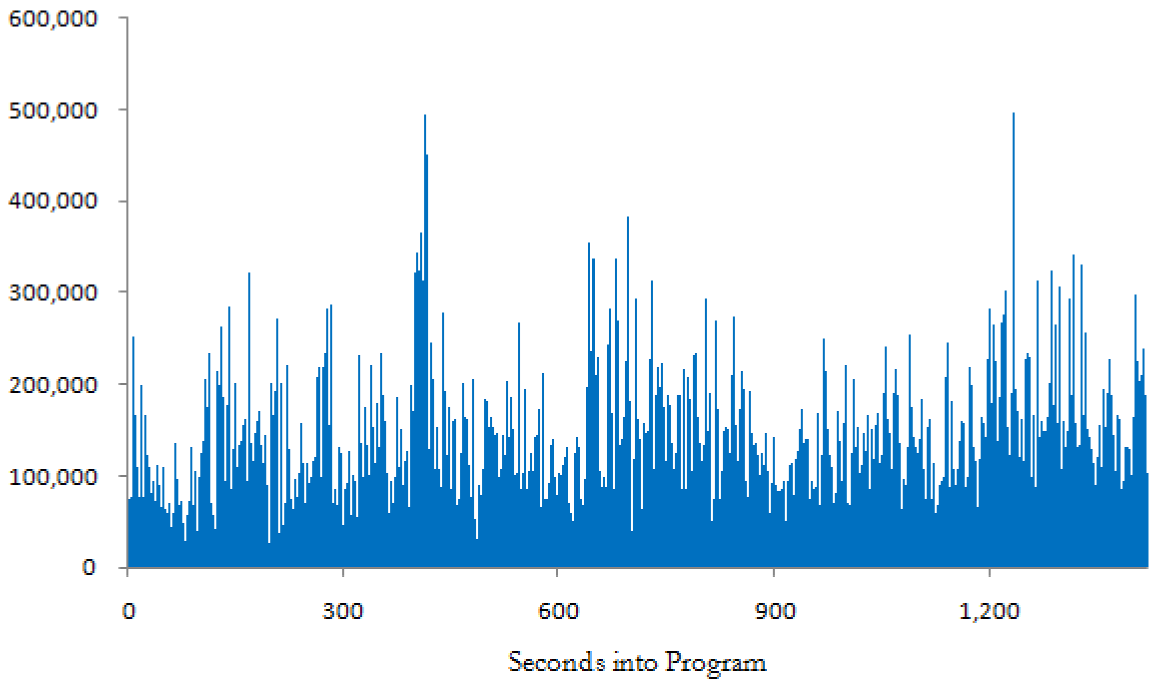

Figure 3: BCEA over time (graphed every 0.1 second).

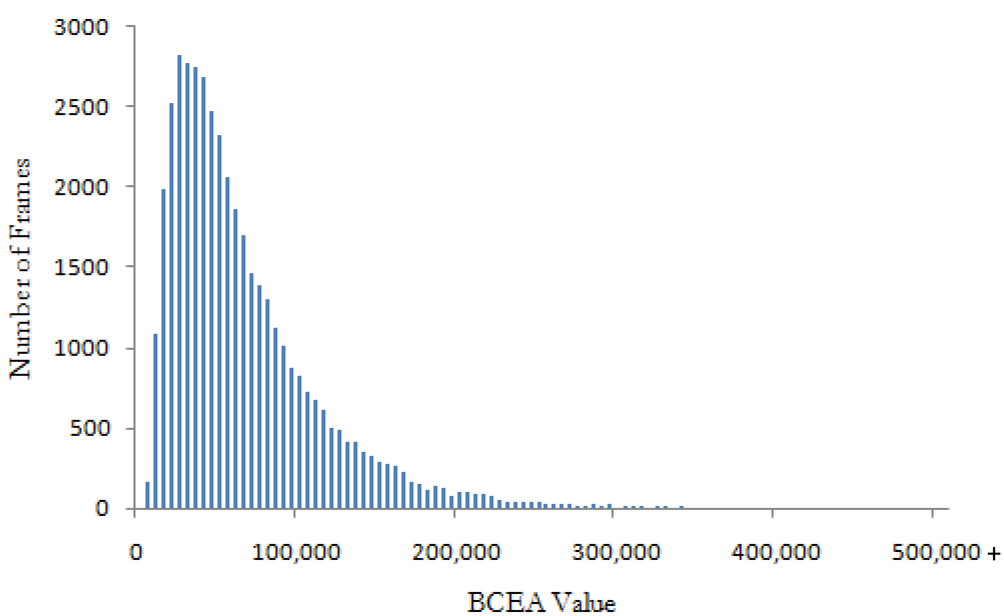

Figure 4: BCEA values histogram.

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 gazepoint 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 due to extreme positive skew in BCEA), show content has significantly higher dispersion than the bumper (t_{527}=17.623, $p < .001$), and ad content has significantly higher dispersion than show content (t_{34563}= 17.45, $p < .001$ for $Ad_{overall}$, t_{19447}=4.07, $p < .001$ for show vs. $Ad_{NoBrand}$, t_{9897}=43.56, $p < .001$ for Show vs. Ad_{Brand}). Looking within the ads, frames with branding have significantly higher dispersion than frames without branding (t_{14927}=39.94, $p < .001$). This could be due to the frequent presence of text in branded frames encouraging more scanpath movement.

	Bumper	Black	Show	Ad: No Brand	Ad: Brand
Mean BCEA across frames	33,029	57,942	56,781	61,210	89,752
Total number of frames	510	678	23,371	11,553	6,429

Table 1: BCEA by show content.

Does familiarity affect dispersion? When repeated advertisements are compared against their first-run counterparts, BCEA is significantly higher for the repeated ads (72,661 vs. 67,469, t_{7763}=3.36, $p < .001$). 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 advertisements. This suggests further work is needed to explore the generalizability beyond the stimulus employed, and build on this exploratory work to explore more causal drivers of gaze dispersion variation.

In conclusion, the distribution of gazepoint locations for a group of participants watching a television show looks highly normal and centered on the screen. This central bias echoes prior work (Tatler, Baddely, and Gilchrist 2005; Le Meur, Le Callet, and Barba 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 advertisements 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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