# The Role of Location and Visual Saliency in Capturing Attention to Outdoor Advertising

## How Location Attributes Increase the Likelihood For a Driver to Notice a Billboard Ad

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The current authors' research addressed the importance of a billboard's location and visual saliency in capturing consumer attention. Visual saliency refers to an advertisement's ability to stand out and attract attention because of its use of color, shading, and compositional design. Building on data from an existing eye-tracking study from the Traffic Audit Bureau for Media Measurement, Inc. (TAB, renamed Geopath in September 2016), the authors found that visual salience has some, but limited, influence on drivers' attention to billboard advertising. Rather, a billboard's location contributed more to the understanding of the distribution of attention in complex environments like roadside advertising. These billboard attributes explained two-thirds of the observed variance in the author's models.

### INTRODUCTION

In attracting consumer attention to an ad, the out-of-home advertising industry has long recognized a billboard's location and visual saliency as critically important (Ephron and Philport, 2005; OAAA, 1983, 2000). Whereas location refers to the placement of a billboard for optimal viewing, such as side of the road, distance from the road, and so on, visual saliency refers to the ability of an advertisement to be noticed based on its visual properties, independent of the structure on which it resides. In the complex visual environments where roadside advertising is typically found, advertisements more likely will be noticed, for reasons pertaining to visual saliency, if an advertisement space includes contrasting colors like red and green, dark and light areas independent of color contrasts, and unique orientations of advertisement components, such as features organized along a real or imaginary axis.

The out-of-home advertising industry values its billboards largely through the calculation of audiences seeing the advertisements. The Traffic Audit Bureau for Media Measurement, Inc. (TAB) is the U.S. industry body responsible for assigning media impressions and ratings to each TAB member advertisement location. These measures are

### Management Slant

- Applying visibility adjustments to billboard circulation brings into play each billboard's location attributes, creating the opportunity to more accurately measure real audience exposure.
- The physical attributes of out-of-home structures and their relative position to the driver significantly impact the likelihood that an advertisement on the unit will be noticed.
- Dwell time also has a significant impact on noticing advertising.
- Visual saliency shows that great creative content can have a significant impact if care is taken to place the advertisement properly.
- The biggest advantage comes from great location coupled with great creative content.

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based solely on the location of each piece of advertisement inventory. TAB makes no adjustment to allow for the impact of strong creative content or the visual saliency of a billboard. This is primarily because of difficulties in quantifying visual saliency and the expense of tracking each advertisement execution. The current research offered a method to objectively quantify visual saliency's measure and evaluate its importance in comparison to and in conjunction with billboard location attributes. By conducting two research studies, the authors found that a billboard's location, indeed, drives attention to advertising. Moreover, strong creative content, as defined through the researchers' visual salience measure, is most effective when the advertisement is properly located within the driving environment.

According to the Advertising Research Foundation, attention to or noticing of advertising is the first stage at which consumers react to the message found within an advertisement (Ephron *et al.*, 2003). TAB's research used eye-tracking studies to determine whether consumers had focused on the advertising message. But eye-tracking studies have a limited scope: Although they can determine what an individual looked at, they cannot determine why the advertisement captured attention. Was a billboard noticed because of its location attributes or because of its visual saliency? In many ways, the effects of an out-of-home message are significantly confounded with the effects of the medium (Ephron *et al.*, 2003).

Incorporating visual saliency as a measure of an advertisement's creative execution into out-of-home attention research and teasing out its effects can help answer why certain advertisements are noticed. A growing number of researchers have made this issue a priority within the industry (Taylor, 2012; Wilson and Till, 2012). In attempting to answer these questions, the authors first assessed the impact location has on noticing, using a subset of TAB primary research data. Second, the authors added in the visual saliency variable to approximate creative execution. To do this, they used a novel software program, called Saliency Toolbox (Walther and Koch, 2006), from the confluence of computational and cognitive neuroscience to mimic the human visual attention process (Itti and Koch, 2000; Itti, Koch, and Niebur, 1998). The software identified objects that likely would have received attention due to visual saliency. It offered a significant methodological improvement opportunity for the advertising research field (Milosavljevic and Cerf, 2008), and software like it has been used in several studies to date (Pieters and Wedel, 2004; van der Lans, Pieters, and Wedel, 2008; Wilson, Baack, and Till, 2015).

## STUDY 1

### Media Measurement And Out-of-Home Advertising

The majority of today's media measurement is still based on people's proximity to programs, editorials, and advertisement content. This means there is no indication whether the advertisements are actually noticed by consumers. This standard often is called "opportunity to see." Opportunity to see is really a proximity measure and not an actual measure of noticing advertising. Although not the only measure of exposure to a medium, opportunity to see is a standard measure across all media. Print measures exposure to its content, and television primarily measures exposure to its programming. The out-of-home billboard version of opportunity to see is circulation. Circulation is defined as the number of people passing by each billboard.

Many within the out-of-home advertising industry believed its proximity measures were insufficient. This is because out-of-home exposure occurs spontaneously and does not require any overt action beyond being outside and moving around (Ephron *et al.*, 2003).

To potentially grow the business, the industry needed a more refined measure that took into account the actual noting of advertisements. Accordingly, TAB developed a more robust measurement system that incorporated a Visibility Adjustment Index used to reduce out-of-home's opportunity-to-see counts. This adjustment provided a metric that more accurately reflected the number of people who likely would see the advertisement. To formulate the adjustment, TAB conducted a study to identify the appropriate variables that affect the noticing of roadside advertising. The results of that study found that roadside advertising more likely would be noticed if it were located closer to the road, located on the right-hand side of the road (in the United States and other right-side driving countries), larger in size, viewable from the center of windshield, and angled appropriately to the road (Traffic Audit Bureau, 2010). TAB collects, calculates, and records the inputs of these variables for each out-of-home advertisement location and then gives an appropriate Visibility Adjustment Index calculation for each advertisement. There is a separate pedestrian study of visibility in use as well, but that portion of the TAB study fell outside of the purposes of the current study, which focused on roadside advertising visible to drivers.

In its effort to develop the Visibility Adjustment Index, TAB consulted earlier industry research conducted by the Outdoor Advertising Association of America (OAAA). These studies proved that billboard attributes do have an impact on noticeability (OAAA, 1983) and that creative content has an impact as well (OAAA, 2000). The latter two studies also proved that color and luminance have an impact on noticing.

TAB also reviewed work done in the United Kingdom. The U.K. out-of-home industry research body Route, formerly known as POSTAR, was the first to take out-of-home audience measurement into the realm of actually seeing the advertisement. They used static imagery to determine noticing of different out-of-home media and developed a Visibility Adjustment Index model for the United Kingdom. TAB was able to benchmark Route/POSTAR's work, and their results were a guide for TAB's own results.

TAB made available its Visibility Adjustment Index scores for the current article (Traffic Audit Bureau, 2010). In this 2010 study, TAB collected the initial noticing and reexamining scores for each billboard studied, but only used noticing scores in its 2010 research, as the purpose was to assess whether the board was seen or not seen. Reexamination scores were collected in case something could be gleaned in future research. Noticing scores ranged from the single digits to more than 80 percent, depending on the quality of the location.

The primary purpose of TAB's visibility research program was to determine the drawing power of out-of-home structures like bulletins or posters and their physical position, not the power of the advertising on the structure. TAB's measurement system focuses specifically on the location, and not the creative content, because it is neither feasible nor practical to have a measure for creative execution, particularly since there is no way to predict creative quality. In its 2010 study, TAB controlled for creative quality by making sure that a wide array of advertisement executions were included (Traffic Audit Bureau, 2010). TAB also graded the creative execution of each advertisement included in the study based on feedback from a panel of senior executives. These grades served as benchmarks that ensured that the creative content was neither overtly poor nor grand and that it was captured appropriately by the video. By controlling for creative content, TAB acknowledged the need for a further investigation on the noticing of advertisements due to visual saliency.

#### Location and Attention to Billboards

Academics and practitioners have identified a number of billboard attributes that influence the amount of attention given to roadside advertising (Taylor, 2010; Traffic Audit Bureau, 2010; Wilson and Till, 2012). These attributes are primarily location based and include a billboard's distance from the road; the side of the road in which it appears; whether it is viewable from the center of the windshield at any point during viewing, called a center approach; its size; and the amount of time in which it is visible to those who pass by it, called dwell time.

For obvious reasons, drivers concentrate a majority of their attentional resources on their forward field of vision (Crundall, Underwood, and Chapman, 2002). Task-relevant objects within this field, such as other vehicles and traffic signs, receive the most attention with only occasional glances to task-irrelevant objects, such as roadside advertising (Chapman and Underwood, 1998). When drivers do attend to roadside advertising, research indicates that 97 percent of glances are within 25 degrees of a driver's forward field of vision and 75 percent are within 10 degrees (Beijer, 2002). Similar results have been found in other outdoor advertising environments, such as airports and shopping malls (Thomas-Smith and Barnett, 2010). Taken together, these studies highlight the importance for billboards to be positioned within a driver's forward and narrow line of sight. Billboards located closer to the road or having a center approach more likely will be noticed.

Drivers make occasional digressions from a forward line of sight to other areas of the driving environment for additional task-relevant information or to simply scan the environment. Drivers have been trained, for example, to look for roadside markers and directional signs on one particular side of the road (Cole and Hughes, 1984; Shinoda, Hayhoe, and Shrivastava, 2001). Scanning the environment for task-relevant information along the roadside creates the possibility for incidental exposure to billboard advertising, and research has shown that advertisements found on the right-hand side of the road in the United States and the left in the United Kingdom have a greater likelihood of being noticed because the advertisement falls within a driver's shifted line of sight (Donthu, Cherian, and Bhargava, 1993; Young *et al.*, 2009).

Also promoting increased attention are larger sized advertisements, which are noticed more frequently than those that are smaller in scale (Hughes and Cole, 1984; Thomas-Smith and Barnett, 2010). One eye-tracking study of roadside advertising found that larger billboards received 0.65 glances per sign per subject, compared with 0.06 glances per sign per subject for smaller billboards (Beijer, 2002). And, in a transit advertising environment, larger advertisements garnered higher levels of recall and recognition than smaller billboards (Wilson and Till, 2008).

These first four variables are part of TAB's Visibility Adjustment Index and were analyzed previously in a larger dataset and found to be highly predictive of an ad's potential to be noticed at least once by drivers (Traffic Audit Bureau, 2010). The current authors explain shortly that they used a smaller portion of the dataset in this study. On the basis of the previously discussed combination of academic and TAB work, the current authors offered the following hypotheses:

H1: Billboard advertising more likely will be noticed if it is closer to the road.

H2: Billboard advertising in the U.S. more likely will be noticed if it is on the right-hand side of the road as opposed to the left-hand side of the road.

H3: Billboard advertising more likely will be noticed if it has a center approach.

H4: Billboard advertising more likely will be noticed if it is larger in size.

TAB's original research (Traffic Audit Bureau, 2010) did not specifically explore the impact of dwell time or the amount of time that a billboard is in a driver's field of vision. In 2013–2014, however, TAB subsequently conducted another visibility study that focused on the impact of dwell time on the noticing of both standard and digital out-of-home advertising. TAB released this enhancement in 2014 as Ratings 2.0 (Traffic Audit Bureau, 2014). In the 2014 TAB study, dwell time was measured in the field by driving respondents at different speeds and in different traffic congestion patterns past billboards. It was confirmed that slower passages, which create longer dwell times, do increase the noticing of all billboards. Dwell time is now part of the permanent audience measurement for all TAB-measured inventories. Accordingly, the current authors also offered the following hypothesis:

H5: Billboard advertising more likely will be noticed if it has a longer dwell time.

## STUDY 1 METHODOLOGY

In Study 1, the authors reanalyzed a portion of the findings from the earlier eye-tracking study performed by TAB and its vendor Perception Research Services (Traffic Audit Bureau, 2010). Perception Research Services, based in Teaneck, N.J., are worldwide experts in eye-tracking technology and have a long history of measuring out-of-home advertising. In that larger study, attention to out-of-home advertising was assessed across both pedestrian panels and roadside billboards. To narrow the scope of their research and to minimize the number of potential confounding variables, the current authors held the advertising format constant, using only billboards visible to those driving. They also added dwell time to the existing mix of Visibility Adjustment Index variables from the 2010 TAB study. Dwell time is an additional dependent variable not previously analyzed in the original 2010 TAB research.

### Subjects

The 2010 TAB study recruited a total of 312 subjects in the first stage of the study who were equally distributed across 10 U.S. cities: Akron, OH; Boston, MA; Chicago, IL; San Antonio, TX; Detroit, MI; Enfield, CT; Fort Lauderdale, FL; Hicksville, NY; Phoenix, AZ; and San Diego, CA. Participants were recruited by telephone and mall intercept, screened to have normal vision, and to be above the age of 18 years. TAB had attempted to recruit an equal split of male and female participants as well as a wide array of ages.

### Stimuli

Video clips for the TAB study had been obtained by mounting a camera at a 72-degree angle inside a vehicle from the driver's point of view as per independent research recommendations (Chapman and Underwood, 1998; Wallis and Bülthoff, 2000). The video had been filmed from a location in the vehicle where its hood was not visible and when there was no reflection from the dash. Because multiple cars had been used across several filming locations, TAB did not want the viewer to be distracted by the hood changing and having sun glare appearing and disappearing randomly during the video loop. Video had been recorded using a high-definition video camera.

A variety of roads in Connecticut, Phoenix, and Chicago had been selected for filming to be representative of a number of driving experiences, including urban/suburban, old/new cities, and different billboard formats, including old or new structures and pole, building, or wall mounts. Every attempt had been made to ensure the driving video was as natural as possible with the vehicle traveling at the same speed as surrounding traffic and in the center lane if multiple lanes in one direction were present. Filming had occurred at midday in sunny or partly sunny weather conditions to ensure that billboard views were comparable and free of glare across video clips.

Video clips varying in length from one to three minutes were carefully merged to create three unique driving sequences. Each video ranged from eight to 12 minutes in length and contained between eight and 11 clips. To minimize hypothesis guessing, some clips contained limited billboards with long spacing between advertisement locations. Each clip faded to black before the next clip faded in to create smooth transitions. A two-second black frame appeared in between each clip. A total of 119 billboards were included across all three driving sequences.

### Procedure

The 2010 TAB study brought participants in the ten previously mentioned testing sites into a testing facility at a local mall in their respective city. The facility included a waiting room area and a separate room where the study took place. Participants randomly were shown one of the three driving sequence videos. They were instructed to watch it as if they were the driver of the vehicle. Participants were told the purpose of the video-clip-viewing exercise was to assess normal driving behaviors, which earlier pilot phase participants had indicated was what they believed the purpose of the study to be. No pilot participant believed the purpose of the study was the noticing of roadside advertising.

Videos were displayed on a new large high-definition television at a distance of about 10 feet, so as to approximate the proper field of view given through a windshield. Participants' eye movements were recorded using an ISCAN ETL-324 eye-tracking system that was mounted to the floor. No headgear was worn. Participants were recorded as fixating on a billboard if they attended to it for at least 0.25 seconds. This minimum threshold was identified by an onsite eye-tracking expert and confirmed by consulting academic research (Sereno and Rayner, 2003).

To verify a driver simulation, 20 stimuli across the three driving sequences were included as objects participants must see to be included in the study, for example, a low-flying airplane on the horizon, a passing car, and so forth. Additionally, participants were observed behind a double mirror to ensure participants remained attentive. Six participants were removed for inattentiveness, leaving 306 participants.

### Variables

TAB defined the noticing of billboards as both the initial noting of a billboard and the subsequent reexamining of a billboard. These two items formed the dependent variables used in the current study. The initial noting score was measured as the percentage of subjects attending to a billboard once for at least 0.25 seconds while the reexamining score was measured as the percentage of participants noting a billboard a second time for at least 0.25 seconds. All location variables needed for each hypothesis were coded separately in the TAB study.

For the independent location variables, a billboard's distance from the road was measured in feet from its base to the closest lane from which it was visible (Hypothesis 1). The side of the road in which a billboard appeared was coded as a 0 for the left-hand side of the road and a 1 for the right-hand side of the road (Hypothesis 2). Whether a billboard was visible from the center of the road was coded as 0 for not having a center approach and 1 for having a center approach (Hypothesis 3). A billboard was considered to have a center approach if it was visible from the center of the windshield at any point during viewing, which was typically within ten degrees of a driver's direct forward-looking glance (five degrees to the right and left of the viewer's eye). Size was measured in square feet of the billboard's display area (Hypothesis 4). A 30-sheet poster would, for example, be commonly listed as 300 square feet (12′ × 25′). Finally, the amount of time a billboard was visible on the video, an indicator of dwell time, was measured in seconds (Hypothesis 5). The authors calculated the dwell-time measure, as it was not part of the 2010 TAB study.

## STUDY 1 RESULTS

A linear regression analysis was used to determine how location attributes influence the initial noting and subsequent reexamining of billboard advertising. Pearson correlations among the independent variables were not greater than 0.37; variance inflation factors (VIFs) for all variables in the regression were less than

## TABLE 1

Pearson Correlation Matrix ($N$ = 119)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Noting | — | | | | | | | | | | |
| 2. Reexamining | 0.95*** | — | | | | | | | | | |
| 3. Distance | −0.42*** | −0.39*** | — | | | | | | | | |
| 4. Side of road | 0.37*** | 0.34*** | 0.06 | — | | | | | | | |
| 5. Center | 0.24** | 0.29** | −0.11 | −0.03 | — | | | | | | |
| 6. Billboard size | 0.24* | 0.25** | 0.29** | 0.10 | 0.09 | — | | | | | |
| 7. Dwell time | 0.31** | 0.39*** | −0.01 | −0.08 | 0.12 | 0.29** | — | | | | |
| 8. Visual saliency (VS) | 0.12 | 0.02 | −0.06 | 0.17 | −0.06 | 0.18* | −0.26** | — | | | |
| 9. VS × Distance | −0.13 | −0.17 | 0.40*** | 0.10 | −0.08 | 0.35*** | −0.12 | 0.73*** | — | | |
| 10. VS × Side of road | 0.29** | 0.19* | −0.07 | 0.57*** | −0.03 | 0.11 | −0.29** | 0.77*** | 0.52*** | — | |
| 11. VS × Center | 0.23* | 0.28** | −0.07 | 0.05 | 0.75*** | 0.15 | 0.16 | 0.06 | −0.01 | 0.07 | — |

*$p \le 0.05$, **$p \le 0.01$, ***$p \le 0.001$

**TABLE 2**

Regression Results for Noting ($N = 119$)

| | Model | | |
|---|---|---|---|
| **Variable** | **1** | **2** | **3** |
| Distance from road | –0.498*** | | –0.371*** |
| Side of road | 0.399*** | | 0.293** |
| Center approach | 0.149* | | 0.212* |
| Billboard size (sq ft) | 0.256** | | 0.264** |
| Dwell time | 0.245** | | 0.303*** |
| Visual saliency | | 0.102 | 0.134 |
| Visual saliency × Distance | | –0.419** | –0.253* |
| Visual saliency × Side of road | | 0.412** | 0.196 |
| Visual saliency × Center approach | | 0.188* | –0.087 |
| Adjusted $R^2$ | 0.509 | 0.201 | 0.522 |
| $\Delta R^2$ | 0.530*** | 0.228*** | 0.029 |
| Model F | 25.487*** | 8.423*** | 15.324*** |

*Note: Standardized Beta coefficients are presented in all models. Sq ft = square feet.*
**p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001*

1.3, suggesting the absence of multicollinearity or that each independent variable in the current model was measuring unique items (See Table 1; Hair *et al.*, 2005).

The results for the initial noting of billboard advertising were significant, adjusted $R^2 = 0.509$, $F(5, 113) = 25.587$, $p < 0.00$ (See Model 1, Table 2). All hypotheses were preliminarily supported. Billboard advertising more likely was noticed because of its distance from the road (Hypothesis 1, $p < 0.00$), side of the road (Hypothesis 2, $p < 0.00$), center approach (Hypothesis 3, $p < 0.05$), billboard size (Hypothesis 4, $p < 0.01$), and dwell time (Hypothesis 5, $p < 0.01$).

The results for the reexamining of billboard advertising were significant, adjusted $R^2 = 0.520$, $F(5, 113) = 26.596$, $p < 0.00$ (See Model 1, Table 3). All hypotheses were preliminarily supported. Billboard advertising more likely will be reexamined because of its distance from the road (Hypothesis 1, $p < 0.00$), side of the road (Hypothesis 2, $p < 0.00$), center approach (Hypothesis 3, $p < 0.01$), billboard size (Hypothesis 4, $p < 0.01$), and dwell time (Hypothesis 5, $p < 0.00$).

The results of the first study generally aligned with the findings from the initial TAB study. Some results differed, however, because the current authors' research used a subset of the data from the original TAB study and added dwell time as an additional independent variable and reexamining as an additional dependent variable. The initial TAB study also presented a multivariate solution while the hypotheses the current authors tested were univariate.

**TABLE 3**

Regression Results for Reexamining ($N = 119$)

| | Model | | |
|---|---|---|---|
| **Variable** | **1** | **2** | **3** |
| Distance from road | –0.450*** | | –0.381*** |
| Side of road | 0.376*** | | 0.305** |
| Center approach | 0.187** | | 0.188 |
| Billboard size (sq ft) | 0.231** | | 0.254** |
| Dwell time | 0.327*** | | 0.341*** |
| Visual saliency | | –0.030 | 0.006 |
| Visual saliency × Distance | | –0.330** | –0.156 |
| Visual saliency × Side of road | | 0.362** | 0.142 |
| Visual saliency × Center approach | | 0.254** | 0.009 |
| Adjusted $R^2$ | 0.530 | 0.164 | 0.514 |
| $\Delta R^2$ | 0.541*** | 0.193*** | 0.010 |
| Model F | 26.596*** | 6.803*** | 14.867*** |

*Note: Standardized Beta coefficients are presented in all models. Sq ft = square feet.*
**p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001*

## STUDY 2

To determine visual saliency's role in the attention capture of billboard advertising, the current authors used visual attention theory from cognitive neuroscience to inform their hypotheses.

### Visual Attention Theory

Visual attention theory suggests that two factors explain why people attend to objects in a visual scene (Treisman and Gelade, 1980; Wolfe, 1994, 1998). The two factors commonly are classified as bottom-up and top-down. These factors are not only applicable to broader visual contexts but also to more specific advertising contexts (Milosavljevic and Cerf, 2008; Pieters and Wedel, 2004).

Bottom-up factors refer to the characteristics of objects that are prominent within the visual field. People attend to these objects reflexively and involuntarily, often because of an object's size, motion, curvature, orientation, color, and luminance. Objects with these characteristics pop out and are generally the first objects to be noticed when individuals orient themselves to a new environment. In a driving context, objects larger in size tend to be more easily noticed than smaller objects (Hughes and Cole, 1984), as are objects that quickly move in and out of a driver's field of vision, such as pedestrians or other vehicles (Shinoda, Hayhoe, and Shrivastava, 2001). Moreover, objects aligned along a real or imaginary axis that possess contrasting colors and that are brighter or darker than other objects in the visual field more likely will be noticed (Underwood, Humphrey, and van Loon, 2011). In a driving situation, these might include a red sign against a blue sky or a line of orange construction barrels.

Bottom-up processing is done quickly and objects are processed in parallel, meaning that multiple objects can be pre-attentively processed simultaneously. Bottom-up factors are thought to have the greatest influence on attention immediately after their onset as people orient themselves to the situation or task (Donk and Soesman, 2010; Le Meur, Le Callet, Barba, and Thoreau, 2006). As time progresses, however, attention to objects due to bottom-up factors decreases as task-driven, top-down factors take hold (Parkhurst, Law, and Niebur, 2002).

Top-down factors are related to cognition and are associated with a person's existing knowledge and expectations about a visual scene (Corbetta and Shulman, 2002). Objects are attended to if they possess task-relevant features (Theeuwes, 2004; Yarbus, 1967). In a driving context, attention related to top-down processing is often is focused on objects containing information that aids in the driving task, such as traffic signs, traffic signals, and objects in the intersection and highway exits (Chapman and Underwood, 1998). Unlike bottom-up processing, which is done in parallel, top-down processing is performed serially and objects are attended to in a particular order depending on the task (Wolfe, 1994).

### Visual Saliency And Attention to Billboards

Three bottom-up features typically are referred to as visual saliency: color; luminance, which can be defined as intensity; bright and dark contrasts; and orientation, as in objects aligned along an axis. They traditionally are grouped together and researched collectively because they represent the best approximation of the visual features detected early in human visual search. Humans also tend to respond to these factors as a group rather than individually (Borji, Sihite, and Itti, 2013; Itti and Koch, 2000; Le Meur and Chevet, 2010).

With respect to out-of-home advertising, visual saliency is defined as the ability for a billboard's creative content, not its physical structure, to be noticed by passersby because of its reflexive or bottom-up properties, meaning its color, intensity, and orientation. Objects, or group of pixels, within the advertisement that have contrasting color combinations (the color dimension); that have stark differences in light and dark (the intensity dimension); and that are arranged along a real or imaginary axis (the orientation dimension), more likely will receive involuntary eye movements. Visual saliency excludes the noticing of objects within a billboard's creative content because of cognitive or top-down factors, like existing knowledge of a scene or the semantic meaning of words, pictures, or graphics.

Objects that are more visually salient tend to be noticed early. This is because attention is distributed broadly over a visual field so the environment can be assessed and relevant objects identified. With the passage of time, or as tasks become more demanding, however, top-down guidance of attention increases in strength and influence and attention becomes much more focused, often described as a spotlight or window of attention (Chen and Zelinsky, 2006). As a result, the role of visual saliency in attracting attention becomes more limited, but it does not disappear entirely (Theeuwes, 2004). Although objects outside the window of attention become too far removed from focal attention to benefit from visually salient properties, visually salient objects within the window of attention can still attract attention despite the predominance of top-down processing (Mortier, Donk, and Theeuwes, 2003; Theeuwes, 1991; Yantis and Jonides, 1990).

The narrowed window of attention is quite relevant to the roadside advertising environment. In this context, drivers primarily focus their attention in their forward-looking visual field where future traffic hazards are likely to be found (Chapman and Underwood, 1998). From a top-down perspective, other vehicles and pedestrians likely will capture their attention. Visually salient objects, however, such as billboard advertising, also may capture attention. This is especially true for billboards with a center approach as it places the advertisement within the driver's forward-looking window of attention. Center-approach billboards with contrasting colors, dark and bright areas, and variation in object orientation likely will capture attention.

Although drivers need to concentrate their narrowed window of attention on their forward-looking visual field, they may also need to scan the environment for street signs and other directional information. Drivers have been trained to look for task-relevant signage close to the road and typically on one side of the road (Trick, Enns, Mills, and Vavrik, 2004). Billboards with visually salient advertising located within a driver's shifted window of attention may then capture this attention.

Results from the first study confirmed that billboards placed within the driver's window of attention more likely would be noticed. Specifically stated, placing a billboard closer to the road, on the right-hand side of the road (in the United States), or with a center approach will help position the billboard within a driver's window of attention and thus create the most optimal situation for noticing. A billboard's ability to attract attention in these circumstances may be greatly enhanced by the visual salience of the creative message it carries. Billboard advertising that possesses contrasting colors, bright and dark areas, and variation in object orientation within the window of attention will have an increased possibility of being noticed (Mortier *et al.*, 2003; Theeuwes, 1991; Yantis and Jonides, 1990). Higher noticing increases the amount of real processing. Visual saliency outside the window of attention was not expected to increase the noticing of a billboard's advertising. As a result of these theories, the authors offered the following hypotheses:

H6: Visually salient advertising on a billboard will have a significant difference in noticing when it is located close to the road.

H7: Visually salient advertising on a billboard will show a significant difference in noticing when it is located on the right-hand side of the road in the U.S.

H8: Visually salient advertising on a billboard will show a significant difference in noticing when it has a center approach.

## STUDY 2 METHODOLOGY

### Procedures

To test Hypotheses 6 through 8, the authors calculated the visual saliency of advertising from billboards in Study 1 using a computational model for visual attention. The model comes from the confluence of cognitive and computational neuroscience and successfully mimics human visual attention behavior (Koch and Ullman, 1985). The most widely used computational model is the one developed by Itti and colleagues (Itti and Koch, 2000; Itti *et al.*, 1998). It relies on computer algorithms to emulate human visual attention, and its prediction of visually salient objects in images has been shown to strongly correlate with actual human behavior and eye-tracking studies (Elazary and Itti, 2008; Le Meur and Chevet, 2010; Parkhurst *et al.*, 2002; Peters, Iyer, Itti, and Koch, 2005). A Matlab algorithm, called Saliency Toolbox (Walther and Koch, 2006), was used as an interface to Itti and colleagues' computational model (hereinafter referred to as simply the visual saliency model). The Saliency Toolbox is a collection of mathematical functions and scripts used to calculate the visual saliency in an image.

The visual saliency model analyzes a static image for the presence of contrasting colors, bright and dark areas, and variations in object orientation. The analysis occurs separately for each of the three bottom-up features by generating a conspicuity map for each variable (See Figure 1). Within each map, the software analyzes the pixelated image using a center-surround methodology. That is, it analyzes a pixel, or group of pixels, and compares it to its neighboring pixels. Areas with significant differences in color, intensity, and orientation are thus extracted from the image as a potential object that is likely to be attended to for stimulus-driven reasons.

Within the color conspicuity map, objects are noticed based on contrasting color combinations of red–green and blue–yellow. For the intensity conspicuity map, objects that are expected to attract attention are identified through a group of pixels with dark centers and bright surrounds, or vice-versa. The orientation conspicuity map is created by searching for pixels that are aligned along 0°, 45°, 90°, and 135° axis. To determine which object, that is, which group of pixels, is the most salient across the entire image, the saliency model linearly sums the three conspicuity maps into one saliency map. The group of pixels with the highest value within the saliency map is selected as the object that most likely would be attended.

To determine the next object that likely would receive attention, the saliency model inhibits the first attended to item, a process that has been demonstrated to occur naturally in human behavior (Posner and Cohen, 1984). This prevents the first object from immediately being reselected as salient. The object is inhibited for approximately 500–900 milliseconds (ms) of simulated time depending on the static image's complexity. Once inhibited, the saliency model recalculates the conspicuity and saliency maps to identify the second most salient object, a process that takes about 30–70 ms.

The program continues this process until all salient objects are identified and the first attended-to object is reselected. Through the selection process of salient objects, the saliency model creates a scan-path plot,

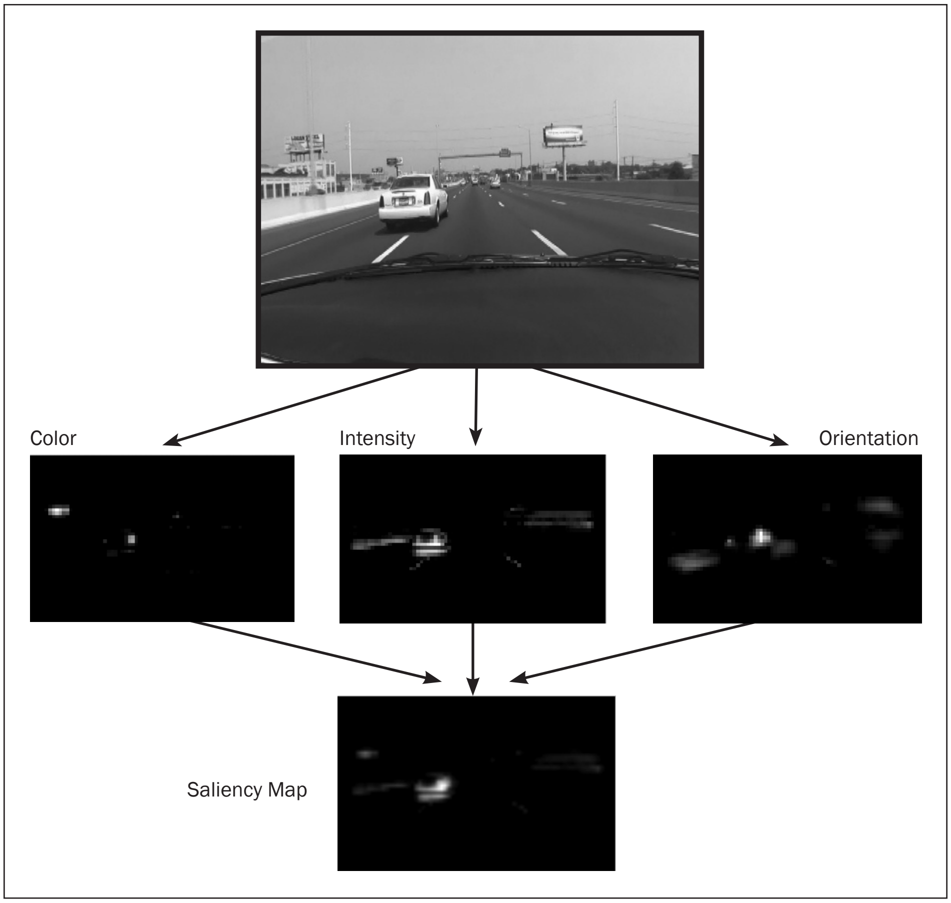


**Figure 1** Conspicuity Maps for Color, Intensity, and Orientation and Overall Saliency Map

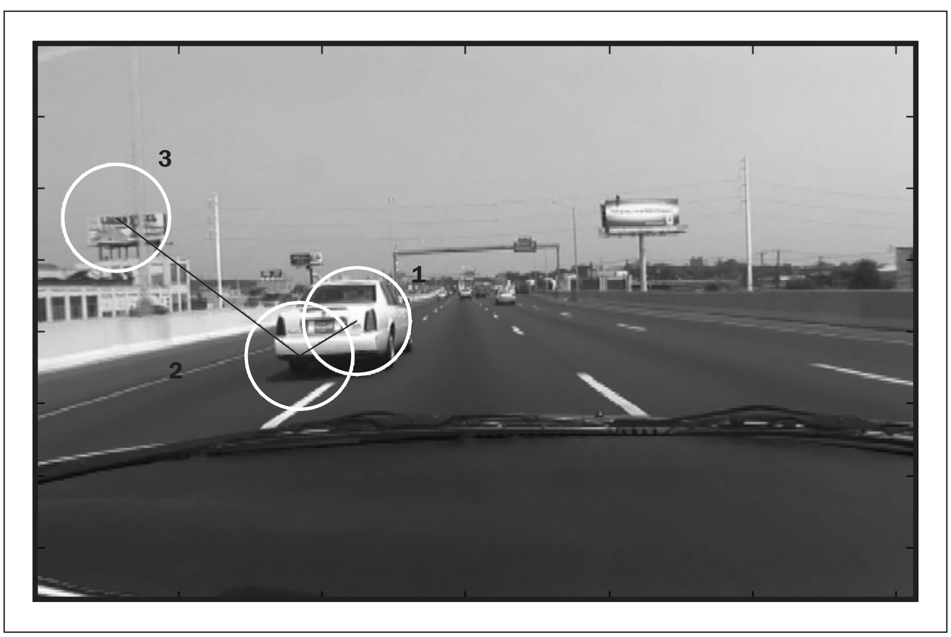


**Figure 2** Abbreviated Scan-Path Plot

which identifies all objects in the order of their selection (See Figure 2). The number of items in a scan-path plot depends on the image's complexity (for more on such issues see Koch and Ullman, 1985; Itti *et al.*, 1998).

### Variables

Based on color, intensity, and orientation, the visual saliency model was set to identify salient objects within a circular focal area having a radius of 1/16 of the image's width (Elazary and Itti, 2008). To determine whether billboard advertising was visually salient, still images from the video from the original TAB study were captured every two seconds. All images containing a target billboard then were analyzed using the visual saliency model and assigned a visual saliency score. If any portion of the billboard's display area was within the focal area and within the first five objects within the scan-path plot, the billboard's advertising was deemed visually salient within that image. Advertising saliency for each billboard then was calculated by summing up the number of images in which a particular billboard's advertising appeared as visually salient and dividing it by the total number of images containing the advertisement. An advertisement visible on screen for 20 seconds, for example, would have 10 images associated with it (one for every two seconds on screen). If an advertisement was visually salient in four of the 10 images, then the advertisement was given a visual saliency score of 0.4 (four divided by ten).

Using the first five objects as visually salient within the scan-path plot has support in the visual attention literature. First, it is consistent with other research that suggests bottom-up saliency is greatest just after stimulus onset (Donk and Soesman, 2010; Le Meur *et al.*, 2006; Parkhurst *et al.*, 2002). Second, the first five locations identified by subjects as visually salient are the most similar across subjects, whereas later fixations are not (Tatler, Baddeley, and Gilchrist, 2005). Third, comparisons using the visual saliency model with what people physically label as generally the most interesting object in outdoor scenes correlates the strongest with the first five objects identified as visually salient (Elazary and Itti, 2006).

To specifically test Hypotheses 6 through 8, three of the location variables were multiplied by the visual saliency score for each billboard advertisement creating three interaction variables: Visual saliency × Distance, Visual saliency × Side of the road, and Visual saliency × Center approach.

**Billboard advertising more likely would be reexamined if the advertising was visually salient and located closer to the road.**

#### STUDY 2 RESULTS

A linear regression analysis was used to assess the impact the visual saliency of a billboard's advertising had on its potential to be initially noticed and subsequently reexamined. Pearson correlations among the independent variables were not greater than 0.77 (See Table 1). Multicollinearity appears not to be an issue as the VIFs for all variables in the regression were less than 2.5 (Hair *et al.*, 2005).

The results for the initial noting of a billboard's advertising were significant, adjusted $R^2 = 0.201$, $F(4, 114) = 8.423$, $p < 0.00$ (See Model 2, Table 2). All hypotheses were preliminarily supported. Billboard advertising more likely would be noticed initially if it was visually salient and located closer to the road (Hypothesis 6, $p < 0.01$), visually salient and on the right-hand side of the road (Hypothesis 7, $p < 0.01$), and visually salient with a center approach (Hypothesis 8, $p < 0.05$). Advertising visual saliency by itself was not significant ($p = 0.532$).

The results for the subsequent reexamination of a billboard's advertising were significant, adjusted $R^2 = 0.164$, $F(4, 114) = 6.803$, $p < 0.00$ (See Model 2, Table 3). All hypotheses were preliminarily supported. Billboard advertising more likely would be reexamined if the advertising was visually salient and located closer to the road (Hypothesis 6, $p < 0.01$), visually salient and on the right-hand side of the road (Hypothesis 7, $p < 0.01$), and visually salient with a center approach (Hypothesis 8, $p < 0.01$). Advertising visual saliency by itself was not significant ($p = 0.856$).

To address the research question of whether visual saliency adds any additional value beyond the location-based attributes, the authors used an additional set of linear regressions combining all variables into one regression equation. One regression was used to assess the variables associated with all eight hypotheses for the initial noticing of billboard advertising and another to assess the subsequent reexamination of billboard advertising. In the new models, the VIFs did increase from earlier models to 6.0, but they were still below the level of ten recommended in marketing research (Mason and Perreault, 1991).

The results for the full model for the initial noting of billboard advertising were significant, adjusted $R^2 = 0.522$, $F(9, 109) = 15.324$, $p < 0.00$, but its adjusted $R^2$ was not significantly improved from the previous adjusted $R^2$ of 0.509 for only location-based attributes ($p = 0.142$) (See Model 1 and 3, Table 2). Six of the eight hypotheses were supported. Billboard advertising more likely would be initially noticed due to its distance from the road (Hypothesis 1, $p < 0.00$), side of the road (Hypothesis 2, $p < 0.01$), center approach (Hypothesis 3, $p < 0.05$), billboard size (Hypothesis 4, $p < 0.01$), dwell time (Hypothesis 5, $p < 0.00$), and whether it was both salient and located closer to the road (Hypothesis 6, $p < 0.05$). Billboard advertising that is visually salient and on the right-hand side of the road (Hypothesis 7, $p = 0.17$) and visually salient with a center approach (Hypothesis 8, $p = 0.39$) were not supported. As expected, advertising visual saliency by itself was also not significant ($p = 0.39$).

The results for the full model for the subsequent reexamination of billboard advertising were significant, adjusted $R^2 = 0.514$, $F(9, 109) = 14.867$, $p < 0.00$, but its adjusted $R^2$ was not significantly improved from the previous adjusted $R^2$ of 0.530 for only location-based attributes ($p = 0.639$) (See Model 1 and 3, Table 3). Only four hypotheses were supported. Billboard advertising more likely would be subsequently reexamined due to its distance from the road (Hypothesis 1, $p < 0.00$), side of the road (Hypothesis 2, $p < 0.01$), billboard size (Hypothesis 4, $p < 0.01$), and dwell time (Hypothesis 6, $p < 0.00$). Center approach (Hypothesis 3, $p = 0.06$), Visually salient × Closer to the road (Hypothesis 6, $p = 0.23$), Visually salient × Side of the road (Hypothesis 7, $p = 0.32$), and Visually salient × Center approach (Hypothesis 8, $p = 0.93$) were not supported. As expected, advertising visual saliency by itself was also not significant ($p = 0.97$).

To better understand these latter regression results and determine which specific variables contributed the most to attention capture, a relative weight analysis was performed. A relative weight analysis is useful in determining the set of predictor variables that maximize the amount of variance explained in the regression equation, which is different than what regression coefficients provide (Tonidandel and LeBreton, 2011). Regression coefficients explain how a one-unit increase in a predictor variable influences the dependent variable while holding all other variables constant. A relative weight analysis explains the contribution each of the predictor variables has on the variance of the dependent variable. Relative weights were calculated using the procedure outlined by Johnson (2000) (See Table 4).

Although the order of importance for the following variables varies across dependent variables, the relative weight analysis shows that distance from the road, side of the road, dwell time, and billboard size were by far the most important variables in explaining both the initial noting and the reexamining of billboards. Collectively, these four variables explained 72 percent and 75 percent of the total variance in noting and reexamining billboard advertising, respectively. No other variable individually contributed more than an additional ten percent toward this explanation.

## TABLE 4

### Relative Weights of Predictor Variables[1]

| | Noting | | Reexamining | |
|---|---|---|---|---|
| **Variable** | **RW[2]** | **Percent[3]** | **RW[2]** | **Percent[3]** |
| Distance from road | 0.153 | 27.5 | 0.136 | 24.5 |
| Side of road | 0.099 | 17.8 | 0.093 | 16.7 |
| Center approach | 0.030 | 5.3 | 0.041 | 7.4 |
| Billboard size (sq ft) | 0.061 | 11.0 | 0.062 | 11.2 |
| Dwell time | 0.089 | 15.9 | 0.124 | 22.3 |
| Visual saliency | 0.022 | 3.9 | 0.012 | 2.1 |
| Visual saliency × Distance | 0.036 | 6.4 | 0.031 | 5.5 |
| Visual saliency × Side of road | 0.054 | 9.7 | 0.033 | 6.0 |
| Visual saliency × Center approach | 0.014 | 2.4 | 0.024 | 4.3 |

*Notes:*
*[1] Full model (Model 3 from Tables 2 and 3)*
*[2] Relative Weight (RW)*
*[3] Percent represents each individual RW's contribution to the sum of RW*

### DISCUSSION OF STUDIES 1 AND 2

A billboard's location and proximity to the driver's window of attention was shown here to be of primary importance. Visual saliency becomes important only when these location criteria are met.

Location-based attributes appeared to have contributed the most to the current authors' understanding of the issue. In fact, the *F* value for the full model decreases quite significantly from the model containing only the location-based variables, which suggests the superiority of location-based attributes in predicting attention to billboard advertising.

The initial noticing of billboard advertising was dependent on its distance from the road, the side of the road in which it appeared, its size, it having a center approach, and it being visible for longer periods of time. Thus, the use of location-based attributes was necessary to develop an accurate and meaningful definition of out-of-home media audiences in a roadside context. It is a higher level definition in that it is based on the likelihood of noticing advertisements.

In the roadside advertising arena, therefore, there is no true definition of audience without understanding each billboard's specific location. In addition to the original variables TAB assigned to its Visibility Adjustment Index (Traffic Audit Bureau, 2010), the current authors added dwell time (the amount of time spent in range of seeing the board) to the list of variables having a significant impact. It was dwell time that connected the contact zone of the respondent to the location attributes of the billboard.

This investigation also went beyond the initial noticing of the advertisement and therefore the original purpose of the TAB research. The authors also examined the environmental and visual saliency aspects against the reexamination of billboards. Understanding reexamination is noteworthy from an audience measurement perspective when it comes to applying these findings to digital billboards. Digital billboards have more than one advertisement on the same location. The rate of reexamining is thus a critical input to applying ratings to individual spots within one digital structure.

The four location-based attributes that impacted the initial noticing of the advertisement also significantly contributed to it receiving a subsequent glance. Distance from the road, side of the road, dwell time, and billboard size are the factors that assisted drivers in the current study to take another look at billboard advertising. One variable, center approach, had no effect on reexamination in the full model. A possible explanation for this is that advertising with a center approach may be noticed and sufficiently processed in the first glance due to its centrality within the forward field of vision thereby negating the need to reexamine it again.

Visual saliency was important within the framework of well-positioned locations, but not as important as location-based attributes. This seems to suggest that bottom-up factors have a limited influence on drivers' attention to task-irrelevant objects such as advertising. Rather, top-down factors contributed more to incidental exposure to advertising stemming from billboards' proximity to objects relevant to the driving task. In other words, billboard advertising appeared to be attended to because it was located close to where other vehicles, pedestrians, traffic signals, and directional signage were found rather than due to its ability to be visually salient within its surroundings (Chapman and Underwood, 1998).

**Despite the technological advances in making eye-tracking glasses much smaller and light weight, their use still poses a possible liability in driving situations that some internal review boards are unlikely to approve.**

It should not be overlooked that one visual saliency feature was significant in the full model. The interaction of visual saliency and distance suggests that billboard advertising, which is able to pop out of its environment, likely would be noticed initially if it was located closer to the road. This appears to confirm the presence of a window of attention effect where bottom-up factors are able to capture attention despite individuals engaging in a highly top-down activity such as driving. The importance of the visual saliency and distance interaction variable seemed to all but disappear, however, when its relative weight in the full model was considered (See Table 4). The interaction variable explained 6.4 percent of the initial noting of billboard advertising, whereas distance by itself explained the most at 27.5 percent. Clearly visual saliency was an important consideration when designing attention-grabbing billboard advertising. Whenever possible, however, priority should be given to selecting a more favorable location rather than to designing an advertisement that contrasts with its environment.

### THEORETICAL IMPLICATIONS

From a theoretical perspective, this study has several important implications. First, the visual saliency model offers a method to operationalize a portion of the theoretical constructs associated with attention to advertising. The model easily identifies an important subset of stimulus-driven, bottom-up advertisement features, and its identification can be done without the cumbersome and at times impractical eye-tracking equipment. This is especially important in driving contexts where the use of eye-tracking equipment can pose safety hazards or limit subjects' periphery vision and range of motion. Despite the technological advances in making eye-tracking glasses much smaller and light weight, their use still poses a possible liability in driving situations that some internal review boards likely would not approve. The current authors hope this study not only stimulates interest but also provides a methodology for how the visual saliency model can be used in future advertising and marketing effectiveness research.

Second, the study continues the momentum building within the marketing literature by using visual attention theories to better understand the effectiveness of promotional tactics (*e.g.*, Pieters and Wedel, 2004; Wilson *et al.*, 2015). This not only enriches researchers' understanding of marketing phenomena but also provides alternative views in how advertising works. Using bottom-up and top-down factors in the discussion of why and how consumers attend to advertising represents a more sophisticated discussion of attention, especially within the out-of-home advertising research stream. Previous research in this area, while certainly contributing to a greater understanding of the medium, often casually mentions an outdoor advertisement's potential to attract attention without tying it more directly to theoretical constructs.

Finally, theoretical implications extend beyond the field of marketing and into the field of vision science. Previous research on the window of attention effect only has occurred in the laboratory using noncontext-relevant stimuli (*e.g.*, Mortier *et al.*, 2003; Theeuwes, 1991; Yantis and Jonides, 1990). As such, the current study extends this area of research into the marketing domain and confirms the existence of the window of attention, at least to some degree, in a roadside advertising context—a progression that some authors have highlighted as a strategic imperative in moving the attentional research forward (Shinoda *et al.*, 2001). Indeed, performing replication research is critical to identifying and verifying substantive and empirical boundary conditions (Evanschitzky, Baumgarth, Hubbard, and Armstrong, 2007).

### PRACTICAL IMPLICATIONS

By providing visibility adjustments to its circulation measures in order to arrive at audience impressions and ratings, the out-of-home industry recognizes that opportunity to see, while used widely in other media's audience measurements, is not the most accurate measure of audiences seeing advertising. Understanding opportunity to

**Applying visibility adjustments to billboard circulation brings into play each billboard's unique location attributes to more accurately measure real audience exposure.**

see is just the first part. Applying visibility adjustments to billboard circulation brings into play each billboard's unique location attributes to more accurately measure real audience exposure. No other media measures actually seeing advertising (Ephron *et al.*, 2003). The current article reaffirms that the physical attributes of out-of-home structures and their relative position to the driver significantly impact the likelihood that an advertisement on the unit will be noticed. Furthermore, this article verified TAB's recently completed study that dwell time also has a significant impact on noticing advertising. TAB studies to date verify that this location premise along with dwell time do matter with quantitative facts.

Great creative execution as a measure of impact was not part of the original TAB study. The current research demonstrates that identifying good locations is very important for noticeability. There is an incremental finding, however, that comes from the power of creative content, operationalized in this study as visual saliency. Visual saliency shows that content and execution can have a significant impact if care is taken to place the advertisement properly. To get the biggest advantage, great location coupled with great creative content is necessary. It is, therefore, possible and worthwhile to evaluate each unit not only on its location specifics but also on whether the advertisement is considered affective within the environment where it is placed. Testing before locations are selected and then selecting billboards based on the TAB ratings system, including dwell time, can make a difference in overall campaign impact.

## LIMITATIONS AND FUTURE RESEARCH

A limitation of this research is that roadside advertising effectiveness was measured using attention given to billboard advertising. The research did not take into account whether the message was processed, retained in memory, or persuasive. Although attention to an advertisement is certainly a necessary condition for message processing, it is not sufficient to ensure that processing occurs (MacInnis and Jaworski, 1989).

An additional limitation is that this research used video rather than an in-field study, which makes it difficult to take into account driver speed and the actual distance a billboard comes into view. This may be less of a concern, however, considering other research has found that simulations produce similar visual attention and task engagement results as compared to field studies (Wang *et al.*, 2010). TAB's 2014 field study of dwell time also confirmed the positive impact of this variable (Traffic Audit Bureau, 2014).

Future research could manipulate various top-down factors to determine their influence on the window of attention. For example, is it possible to shift the window of attention by altering top-down goals? Also, research should consider an additional measurement for advertising effectiveness beyond attention with out of home, such as recognition or recall, attitudes, beliefs, and purchase intent (Wilson *et al.*, 2015; Wilson and Till, 2011). JAR

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