

The authors examine consumers' visual attention during repeated exposures to print advertisements using eye-tracking methodology. The authors propose a statistical model comprising submodels for two key measures of visual attention to elements of the advertisement: attention duration and inter- and intraelement saccades. These measures are vital to understanding attention wear-out and the impact of repetition on advertising effectiveness but have not been considered in previous research. The results of two studies show that (1) attention duration decreases significantly across advertising repetitions and (2) attentional scanpaths, as measured through saccades, remain constant across advertising repetitions and across experimentally induced and naturally occurring conditions. Scanpaths obey a stationary, reversible, first-order Markov process. The authors offer implications for attention theory and advertising processing.

Visual Attention to Repeated Print Advertising: A Test of Scanpath Theory

The effectiveness of repeated print advertisements may decrease because of attention, learning, and acceptance wear-out (Rossiter and Percy 1997). Most research to date has emphasized learning and acceptance wear-out and examined the relationships among repeated advertising exposure, cognitive processes, and affect toward the ad (cf. Anand and Sternthal 1990; Haugtvedt et al. 1994; Rethans, Swasy, and Marks 1986). This research has revealed a non-monotonic inverted-U relationship between exposure and affect toward the ad and has identified several factors that moderate the relationship. To date, few studies have examined attention wear-out. This is surprising because of the central role assigned to attention in advertising communication processes (Rossiter and Percy 1983, 1997; Shanteau 1983), particularly in advertising wear-in and wear-out across repetitions (Batra and Ray 1986; Craig, Sternthal, and Leavitt 1976; Pechmann and Stewart 1989). Calder and Sternthal (1980) argue that inattention is a major cause of re-

peated advertising's wear-out; that is, with increased repetition, consumers pay progressively less attention to advertisements. This contention receives indirect support in prior research on learning wear-out, which shows a decline in brand name recall when advertising repetition increases beyond some threshold (Craig, Sternthal, and Leavitt 1976). However, empirical support using direct measures of attention wear-out is not available (cf. Unnava and Burnkrant 1991).

This study addresses attention wear-out and is the first to analyze visual attention to repeated advertising using eye tracking. We propose a methodology that enables us to examine closely specific patterns of visual attention to key elements of advertising. The methodology builds on scanpath theory (Noton and Stark 1971; Stark 1994) that postulates relatively stable patterns of eye fixations. These patterns facilitate identification of the advertisements' content in repeated exposures. In addition, we investigate if and how these scanpaths change across advertising repetitions and whether other factors affect attention wear-out, in particular, ad design and consumer motivation.

Research on ad repetition typically has used television commercials (Axelrod 1980; Batra and Ray 1986; Belch 1982; Calder and Sternthal 1980; Haugtvedt et al. 1994; Rethans, Swasy, and Marks 1986), which are characterized by fixed, externally controlled exposure duration. In contrast, consumers control the exposure duration to print advertising themselves. This offers them ways to adapt to repetition by reducing or increasing the duration of exposure to advertisements. The few studies on repetition of print advertising typically either have examined advertising under

*Rik Pieters is Professor of Marketing, Department of Business Administration, Tilburg University, The Netherlands (e-mail: F.G.M. Pieters@kub.nl). Edward Rosbergen presently is employed at MuConsult, Amersfoort, The Netherlands (e-mail:). During the research on which this article is based, he was a doctoral candidate in Marketing Research. Michel Wedel is Professor of Marketing Research, Department of Economics, University of Groningen, The Netherlands (e-mail: wedel@eco.rug.nl). This research was sponsored by Verify Nederland, Rotterdam, and the Economic Research Foundation, which is part of the Netherlands Organization for Scientific Research (NWO). The authors gratefully acknowledge the support of Dominique Claessens of Verify Nederland throughout the research. To interact with colleagues on specific articles in this issue, see "Feedback" on the JMR Web site at www.ama.org/pubs/jmr.

fixed exposure duration (Berger and Mitchell 1989; Unnava and Burnkrant 1991) or have not measured exposure duration at all (Cox and Cox 1988). As a consequence, little is known about the effect of repetition on attention to advertising if the exposure duration is under consumer control, such as for print, outdoor, Internet, and yellow page advertisements. In particular, when exposure duration is under consumer control, the investigation of attention wear-out is important because it may preclude the occurrence of learning or acceptance wear-out. That is, attention wear-out may cause consumers to terminate exposure to advertising before the other types of wear-out set in. Rossiter and Percy (1997, p. 602) state that "Diminished attention is particularly likely to affect campaigns in print media where the easy response for the consumer or customer is to turn the page."

In this study, we examine the effect of repeated exposure on consumers' attention to print advertising, using eye recordings as measures of visual attention. Here, consumers control the duration of the exposure to the print advertisements. We examine measures of attention to the key elements of an advertisement: headline, pictorial, body text, and packshot. We conduct two studies to compare the effects of repetition on attention in different set-ups. In the first study, consumers' motivation to attend to a print advertisement for shampoo and the quality of arguments in the advertisement are manipulated systematically to establish the generalizability of repetition effects across those relevant consumer and stimulus conditions (Batra and Ray 1986). In the second study, attention to three advertisements for three different personal care products is examined with naturally occurring differences in consumers' motivation to explore the generalizability of repetition effects across different study and ad designs. We propose a stochastic model of consumers' visual attention to advertising that enables detailed analyses of the duration of attention to key elements and of the eye movements within and between those elements. In this way, insight is obtained into patterns of visual attention that have not been examined previously but that seem crucial to understand the processing and effectiveness of repeated print advertising.

VISUAL ATTENTION TO ADVERTISING

Because eyes go where attention is allocated (Rayner 1995), eye movements provide reliable information about consumers' visual attention to advertisements (Krugman et al. 1994; Rosbergen, Pieters, and Wedel 1997). Apart from several smaller, corrective eye movements, eye movement data are composed of saccades and fixations. *Saccades* are the quick jumps of the eye from location to location, during which vision essentially is suppressed. *Fixations* are the pauses between saccades, during which the eye is relatively immobile. They are an important aspect of visual attention, and the evaluation of an advertisement's potential to gain attention should be based on the duration, position, and pattern of these fixations.

In basic research on reading (Rayner 1995) and visual scanning (Viviani 1990), fixations typically are analyzed at the most desaggregate level, at which the exact position and duration of each individual fixation is retained. In studying visual attention to print advertising, there are advantages to assigning fixations to areas instead of retaining their exact positions. First, in advertising development and subsequent

copy testing, the goal is to understand whether and how frequently consumers attend to ad elements, such as brand name, product, headline, and pictorial, rather than to know the exact coordinates of consumers' fixations on, for example, the headline. Print recognition copy tests, such as Starch, also focus on those key ad elements. Second, at each eye fixation, the visual field covers more than just the exact fixation point because of foveal ("yellow spot") and parafoveal (the surrounding area of the retina) vision. Because a larger part of the advertisement is covered in each fixation than is suggested by exact fixation positions (Rayner 1995), predefined areas of the advertisement are more appropriate as the unit of analysis than exact fixation points. Third, with the number of fixations and saccades that occur during a single exposure to an advertisement, the dimensionality of the data becomes prohibitively large when based on exact fixation positions instead of on a limited number of areas.

Aggregation of raw eye-tracking data is thus desirable in studying attention to advertisements, but the level of aggregation must be determined. Previous advertising research typically has used global information such as the gaze duration, that is, the total time subjects spent on the advertisement or its elements, to examine visual attention (e.g., Celsi and Olson 1988; Janiszewski 1993; Rosbergen, Pieters, and Wedel 1997). In this study, we use information about gaze duration as well, but to examine attention scanpaths to print advertisements in detail, we supplant this with more fine-grained information about inter- and intraelement saccades.

Whereas previously, eye fixations have been treated deterministically, we offer a stochastic model to analyze element-level eye-tracking data for print advertisements and to examine regularities in fixation patterns. The model is based on scanpath theory (Noton and Stark 1971; Stark 1994), and it accounts for the impact of repetition and exogenous variables on those patterns. Before presenting the model, we first introduce relevant attention research, in particular scanpath theory, and formulate hypotheses about visual attention to repeated print advertising.

HYPOTHESES ABOUT VISUAL ATTENTION TO REPEATED ADVERTISING

Attention Duration Decrement Across Advertisement Repetitions

Attention to a television commercial appears to increase initially with repeated exposures and to decrease after a satiation point is reached, which is often after two or three exposures (e.g., Belch 1982; Cacioppo and Petty 1979, 1980; Calder and Sternthal 1980). With externally paced media such as television and radio, one exposure to a commercial message may be insufficient to grasp its content fully, in which case additional exposures are needed. It is not obvious that such an attention pattern also emerges for advertisements in internally paced media such as newspapers, magazines, and the Internet. With internally paced media, consumers can pay as much attention as they desire during the first exposure and can move freely to the next page whenever they are ready. Several researchers have argued that, for print advertising, one exposure may suffice to communicate its message (Calder and Sternthal 1980; Krugman 1972). In that case, the amount of attention paid to the advertisement will decline after the first exposure. Because a

glimpse of an advertisement suffices to identify its familiar content, subjects would spend less time on advertisements in subsequent exposures (Krugman 1972). This leads to the following hypothesis:

- H_1 : Gaze duration and fixation frequency to print advertisements decrease across repeated exposures.

Scanpath Robustness Across Advertisement Repetitions

Scanpath theory (Noton and Stark 1971; Stark 1994; Stark and Ellis 1981) conjectures that sequences of fixations, called "scanpaths," that occur during the first exposure to a stimulus reoccur during subsequent exposures. A spatial model, considered a precognitive, perceptual model, is assumed to control the sequences of eye movements. As a case in point, research indicates that when a subject engages in visual imagery, looking at a blank screen and visualizing a previously seen figure, the scanpath is similar to when he or she viewed the figure (Stark 1994).

Ellis and Smith (1985) propose that scanpaths can be generated by completely random, stratified random, or statistically dependent stochastic processes, but they did not test those conjectures. A completely random process assumes that each element of an advertisement has equal probability of being focused on during each fixation. If eye movements would follow a stratified random (or a zero-order) process, the probabilities of ad elements being fixated reflect the attentional attractiveness of those elements, but they do not depend on previous fixations. In view of the perceptual processes that are assumed to underlie eye movements (Rayner 1995; Stark and Ellis 1981), it is unlikely that saccades from one fixation point to another are generated by either completely random or stratified random processes. A statistically dependent stochastic process, however, specifies that the position of a fixation depends on previous fixations. This would imply that the pattern of fixations can be described by a Markov process (Ross 1996). Molnar and Ratsikas (1987) propose that each fixation's position only depends on the directly preceding fixation point. From this, it would follow that the dependence between successive fixations on ad elements follows a first-order Markov process. Ellis and Smith (1985) argue that saccades from, say, element A to B occur as often as saccades from B to A. This means that the Markov transition probabilities describing the scanpath are symmetrical, or that the first-order Markov process is (time-) reversible (Ross 1996).

Scanpath theory predicts that a subject scans a new stimulus during the first exposure and stores the sequence of fixations in memory as a spatial model, so that a scanpath is established. When the subject is reexposed to the stimulus, the eyes tend to follow the same scanpath, which facilitates stimulus recognition. The theory thus suggests that scanpaths are stationary across exposures. Surprisingly, scanpaths have been treated deterministically in empirical research to date (e.g., Groner 1988; Groner and Menz 1985), and the appropriateness of the Markov assumptions for scanpaths has remained untested. We test the following hypothesis about consumers' scanpaths across repeated advertisements:

- H_2 : Fixations to elements of a print advertisement (a) depend on the location of the previous fixation and (b) are independent of the fixation order of the elements, and (c) their pattern remains constant across repetitions.

H_2 is supported if scanpaths can be described by a stationary, reversible, first-order Markov process. Support for both H_1 and H_2 would imply that the duration of attention to print advertising decreases across repetitions but that, at the same time, the scanpath to elements of print advertising remains constant.

Scanpath Robustness Across Consumer and Message Differences

In a review of the attitudinal effects of advertising repetition, Pechmann and Stewart (1989, p. 287) argue that such effects are contingent on "whether the ad persuades via emotional images or verbal arguments, whether initially it is a high or low scoring ad (for example, whether the verbal arguments are strong or weak), and whether or not consumers are motivated and able to process the ad." We examine the robustness of attentional effects of advertising repetition, following the suggestions of Pechmann and Stewart (1989). Specifically, we test the robustness of attention duration and scanpaths across differences in consumer motivation and argument quality, as is explained subsequently.

Kroeber-Riel (1993) reports that motivated consumers pay more attention to textual elements than less motivated consumers do, and Celsi and Olson (1988) find that motivated consumers overall spent more time processing advertisements. Research on the interaction between consumer motivation and advertising repetition on patterns of visual attention is absent. We test whether motivated consumers pay more attention to print advertising and its elements and whether attention patterns are robust across motivation conditions.

Many studies have found significant effects of argument quality on attitude formation and change (e.g., Petty, Cacioppo, and Schumann 1983; Unnava and Burnkrant 1991), but none has examined argument quality effects on attention. Attitude formation and change are conceptual processes that follow and build on the perceptual processes that are central to visual attention (cf. Greenwald and Leavitt 1984; Viviani 1990). Argument quality is a message variable that is the focus of conceptual processes during advertising exposure. Previous research has found that physical features of advertisements (size, location, color) affect visual attention (Rosbergen, Pieters, and Wedel 1997), but as long as differences in argument quality do not translate into differences in the physical features of advertisements, argument quality is unlikely to affect visual attention. This leads to the following hypothesis:

- H_3 : (a) Consumer motivation has a positive effect, and (b) argument quality has no effect on duration of attention to advertisements.

If H_1 is supported, attention duration diminishes across successive exposures to print advertising. If H_{3a} and H_{3b} are supported, consumers high in motivation pay more attention to print advertising than consumers low in motivation do, but the quality of arguments has no significant effect on attention duration.

Finally, direct evidence regarding the effects of motivation and argument quality on consumers' scanpaths is absent. Molnar and Ratsikas (1987, p. 371) argue that "there are no differences between subjects in the statistical structure of visual exploration," implying that scanpaths do not

differ systematically between subjects. They observe that many sequences of three, four, and sometimes five fixations were nearly identical for several subjects. Similarly, Groner and Menz (1985) find support that scanpaths do not differ across subjects. The observed stability across subjects suggests that neither motivation nor argument quality affect consumers' scanpaths, but these relationships have not been tested experimentally. We offer the following hypothesis:

H₄: Advertisement scanpaths are stable across levels of (a) consumer motivation and (b) argument quality.

Support for all four hypotheses would provide strong evidence for scanpath theory and detailed insight into processes of attention wear-out across repeated exposures to print advertising. It would imply that, though attention duration decreases across ad repetitions (H₁) and though differences in consumer motivation lead to differences in attention duration (H₃), scanpaths exhibit a first-order, reversible Markov process (H₂), which is stable across consumer motivation and argument quality conditions (H₄) and across repeated exposures (H₂).

THE VISUAL ATTENTION MODEL

To examine the visual attention process and test the hypotheses, we propose submodels for attention duration and attention scanpaths. We describe the submodels, along with the nested model tests employed to test the hypotheses. At the end of this section, we summarize how each of the hypotheses is tested specifically.

Gamma Model for Attention Duration

Rosbergen, Pieters, and Wedel (1997) recently showed that gaze duration, defined as the number of seconds subject *i* attends to ad element *j* during exposure *r*, or *d*_{ijr}, can be described adequately by a gamma distribution:

$$(1) \quad f(d_{ijr}) = \left[\frac{1}{\Gamma(\lambda)} \right] \left[\left(\frac{\lambda}{\tau_j^r} \right)^\lambda d_{ijr}^{\lambda-1} \exp\left(-\frac{\lambda d_{ijr}}{\tau_j^r}\right) \right],$$

where τ_j^r represents the expected number of seconds subjects attend to ad element *j* during exposure *r*, and λ represents a dispersion parameter. The gamma distribution is derived from the assumption that an individual fixation has a constant termination hazard, so that the duration of individual fixations is exponential. The attention duration for a particular element is the sum of several fixations, each exponentially distributed, which leads to a gamma distribution (cf. Rosbergen, Pieters, and Wedel 1997). We use the gamma model to investigate differences in attention duration across exposures. In addition, the expected attention duration, τ_j^r , is modeled as a function of motivation or argument quality. More specifically, we model $\ln(\tau_j^r)$ using a linear formulation [ERMQ], where *E* stands for the elements in the advertisement, *R* for repetitions of the advertisement, *M* for motivation of the consumer, and *Q* for quality of the arguments (for the use of the log-linear model notation, see Agresti 1990), and we estimate specific nested versions of the full model [ERMQ]. For example, the model [E,R] involves only main effects of elements and repetitions.

Repeated exposures. The gamma model is used in particular to test H₁, that subsequent repetitions result in a decreased duration of attention. This hypothesis is tested by in-

vestigating whether adding the effect of repetitions, *R*, to a model that only accounts for differences in advertisement elements, *E*, denoted by [E,R], leads to a significant improvement in fit in terms of the log-likelihood.

Motivation and argument quality. In addition, the gamma model is used to test the effects of motivation and argument quality on attention duration by examining the contribution of *M* (H_{3a}) and *Q* (H_{3b}) to model fit. Specifically, the models [E,R,M] and [E,R,Q] are compared with [E,R] using likelihood ratio tests.

Heterogeneous Markov Model for Attention Scanpaths

We represent the consumer's attention scanpath for an advertisement as a Markov chain on a directed graph, in which vertices represent eye fixations on ad elements and edges represent saccades between those elements. We describe the attention scanpath by a stochastic model that involves the probabilities that the consumer's eyes move from ad element *j* to ad element *k*, $p_{k|j}$. We assume that scanpaths across ad elements can be described by a first-order Markov process. That is, each eye fixation only depends on the previous one, and for each subject *i* and each exposure *r*, $p_{k|j}^r$, the conditional probability that the consumer's eyes move from ad element *j* to ad element *k* is as follows:

$$(2) \quad p_{k|j}^r = \frac{m_{jk}^r}{\sum_{k=1}^K m_{jk}^r},$$

where m_{jk}^r denotes the expected number of saccades from *j* to *k* during exposure *r*. Equation 2 is consistent with a Poisson process that produces the inter- and intraelement saccades with expectation m_{jk}^r (Lindsey 1995).

Rosbergen, Pieters, and Wedel (1997) demonstrate that research on visual attention should take heterogeneity between subjects into account. In this study, we account for intersubject variability in the expected number of saccades, m_{jk}^r , by making the standard assumption that m_{jk}^r is a random variable that follows a gamma distribution with mean μ_{jk}^r and dispersion parameter *v* (McCullagh and Nelder 1989). In that case, the observed saccade frequencies, y_{ijk}^r , follow a negative binomial distribution (Markov NBD):

$$(3) \quad f(y_{ijk}^r) = \left[\frac{\Gamma(y_{ijk}^r + v)}{y_{ijk}^r! \Gamma(v)} \right] \left(\frac{v}{\mu_{jk}^r + v} \right)^v \left(\frac{\mu_{jk}^r}{\mu_{jk}^r + v} \right)^{y_{ijk}^r}.$$

The model assumes that differences between consumers are random and can be represented by a gamma distribution, but we examine the presence of structural differences across the motivation or argument quality conditions as well.

To test the hypotheses, we formulate the log-expectation of the Markov NBD, $\ln(\mu_{jk}^r)$, as nested versions of the linear model [ODRMQ], where *O* denotes the origin (rows, ad elements) in the transition matrix, *D* the destination (columns, ad elements) in the transition matrix, and *R*, *M*, and *Q* are defined as previously. The hypotheses regarding the pattern of fixations and saccades are tested by comparing models that impose different nested structures, as we explain subsequently.

Repeated exposures. Similar to the gamma model, H₁, which predicts an attention decrement across repeated expo-

tures, is tested by comparing [O,D,R] with [O,D]. This tests whether the decrease in the number of fixations that consumers devote to the advertisement and its elements across repetitions is significant.

First-order dependence. To test the three possible stochastic processes that may underlie visual scanning of an advertisement, we define three different models: [-] for the completely random process, [O,D] for the stratified random process, and [OD] for the statistically dependent process. We test H_{2a} for first-order dependence of the scanpath by examining the relative fit of [OD] versus [O,D] and use [-], the random process, as the benchmark model.

Reversibility. H_{2b} postulates that the scanpath is reversible; that is, the number of saccades from ad element j to k , $m_{jk}^r = p_{jk}^r | p_j^r$, is equal to the number of saccades from k to j , $m_{kj}^r = p_{kj}^r | p_k^r$ (Ross 1996), where p_j^r is the proportion of eye fixations directed at ad element j . Reversibility of the scanpath can be tested by comparing the reversible Markov process characterized by a quasi-symmetric structure, [O,D,S], where S represents symmetry, with an unrestricted Markov process, [OD]. Here, [O,D,S] is a model that, apart from the distorting effects of the marginal proportions defined by O and D, restricts the expectation of ad element (j,k) in the transition matrix to be equal to that of ad element (k,j) for all k and j . The term S has as many levels as there are paired combinations (jk) and (kj) where j is unequal to k and specifies each symmetric pair to have the same level (Lindsey 1995). Accounting for the effect of ad repetitions, H_{2b} is supported if the difference in the log-likelihood of [O,D,S,R] and [OD,R] is insignificant.

Stationarity. H_{2c} predicts that the scanpath of consumers who are exposed repeatedly to the same advertisement remains constant across repetitions. That is, the hypothesis predicts that the Markov chain is stationary and that transition probabilities are constant across repetitions. Such a stationary Markov process implies that the interaction effects OR and ODR are simultaneously zero (Lindsey 1995). Thus, we test H_{2c} for quasi-symmetry by comparing the log-likelihood of the model [OR,D,SR] and that of [O,D,S,R].

Consumer motivation and argument quality. Similar to the gamma model, the Markov model is used to test the effects of consumer motivation and argument quality on fixation frequency (H_3), by comparing the log-likelihood of the model [O,D,S,R,M] with, respectively, [O,D,S,R,Q] and [O,D,S,R]. In addition, H_4 , which predicts that individuals essentially exhibit the same statistical structure of visual scanning and thus have identical scanpaths, is investigated by testing the robustness of the scanpath across conditions in which levels of consumer motivation or argument quality vary. For the scanpath to be stationary across consumer motivation and argument quality conditions, the interactive effect of M and Q with S should not be significant. Thus, we test H_4 for heterogeneity across advertisement and consumer conditions by comparing the log-likelihood of models [OM,D,SM,R] and [OQ,D,SQ,R] with that of [O,D,S,R].

To summarize, we test H_1 to H_4 by comparing the following nested models:

- H_1 : [E,R] versus [E] for gaze duration, and [O,D,R] versus [O,D] for scanpaths;
- H_{2a} : [OD,R] versus [O,D,R] versus [-] for scanpaths;
- H_{2b} : [O,D,S,R] versus [OD,R] for scanpaths;
- H_{2c} : [OR,D,SR] versus [O,D,S,R] for scanpaths;

- H_{3a} : [E,R,M] versus [E,R] for gaze duration, and [O,D,S,R,M] versus [O,D,S,R] for scanpaths;
- H_{3b} : [E,R,Q] versus [E,R] for gaze duration, and [O,D,S,R,Q] versus [O,D,S,R] for scanpaths;
- H_{4a} : [OM,D,SM,R] versus [O,D,S,R] for scanpaths; and
- H_{4b} : [OQ,D,SQ,R] versus [O,D,S,R] for scanpaths.

Model Estimation and Selection

All models are estimated with the method of maximum likelihood using computer programs written in Gauss (Aptech 1992). The optimal model specifications for the gamma and the Markov NBD models are determined by comparing nested models on the basis of the consistent Akaike information criterion (CAIC; Bozdogan 1987), and likelihood ratio (LR) tests. Because of the relatively large number of tests performed across the two studies, we report results at a significance level of $p < .01$.

DESIGN OF THE STUDIES

Two studies were conducted. In the first study, consumers' motivation to attend to a print advertisement for shampoo and the quality of arguments in the advertisement were manipulated systematically to test the hypotheses and establish the generalizability of repetition effects across consumer and stimulus conditions. Subjects were presented with the advertisements on slides projected on a screen in a predetermined order. Although Study 1 yields high internal validity and is well suited to test our hypotheses, the experimental design and the particular print advertisement used may limit the external validity of the results. One specific advertisement for one brand of shampoo was used, subjects were not exposed to the advertisement in its natural context (i.e., in a magazine), only a single sequence of advertisements was used, and differences in consumer motivation were manipulated. A second study was performed to extend and complement the first study in several important ways. Study 2 uses three different advertisements for grooming and personal care products, a larger sample of subjects, and a more natural exposure context (an electronic magazine) with controlled order of ad exposure and naturally occurring differences in consumer motivation, as we explain subsequently.

Study 1

Sample, stimuli, and procedure. Sixty-eight randomly selected consumers, 19 to 52 years of age, who wore neither glasses nor contact lenses, were invited to come to the office of the market research company that conducted the experiment. The experiment lasted approximately half an hour, and subjects were paid the equivalent of \$20 for their participation.

On entering the experimental room, subjects received a booklet containing instructions regarding the experiment. They were instructed to watch carefully a series of slides of "draft" versions of print advertisements. The advertisements promoted eight different products. Half the subjects were told that the study's purpose was to gain insight into the impact of information within advertisements on judgments about the products advertised and were promised a choice of shampoo at the end of the session (high motivation condition; for similar instructions, see Petty, Cacioppo, and Schumann 1983). The other half were told that the purpose was to develop a new method for testing "draft" versions of

advertisements and that they were to evaluate the advertisements (low motivation condition). These instructions were aimed to stimulate differences in situational involvement (cf. Miniard et al. 1991; Rosbergen, Pieters, and Wedel 1997), or what Celsi and Olson (1988) call situational sources of personal relevance.

The study's target advertisement, an advertisement for a new brand of shampoo, Aquavital, appeared in the second, fourth, and ninth positions. Two versions of the advertisement were designed specially by an advertising agency. Both versions contained four elements: a headline, a pictorial, a packshot, and body text with five textual arguments in favor of the product. The arguments were either strong (e.g., "The sea extracts in Aquavital provide natural nutrients essential to the strength and vitality of your hair") or weak (e.g., "It is suited to everyone's hair"), and the content of the headline was adjusted to the type of arguments used. Argument selection was based on the results of a pilot study. The combination of headline and arguments was tested on its persuasive force. We show the target advertisement for the weak argument condition at the top left corner of Figure 1 (advertisement A).

Subjects were seated in front of a screen, on which the slides were projected from the back, and they were instructed to place their chin on a small chin rest. Eye positions were recorded 50 times per second by an infrared camera located at the subject's left side, such as not to interfere with normal viewing behavior (Young and Sheena 1975). The camera was trained on the subject's right eye, and subjects performed a calibration task. Before they were exposed to the 13 advertisements, subjects were instructed to press a button in front of them to go through the advertisements at their own pace, but advertisements were shown to the subjects for 20 seconds at most.

After attending to the advertisements, subjects completed a questionnaire containing questions about their motivation to process the advertisement and the perceived quality of the arguments in it. Motivation to process the advertisement was measured by asking subjects to rate, on a seven-point scale ("completely agree"/"completely disagree"), their motivation to evaluate the arguments listed in the advertisement. Argument quality was measured by having subjects rate the arguments on three seven-point items. All items ranged from +3 (highest) to -3 (lowest), and scores on the three items were averaged (coefficient alpha = .91).

Manipulation and reliability checks. Analysis of variance shows that subjects in the high motivation condition score, on average, approximately one point higher on motivation to evaluate the arguments listed in the shampoo advertisement than subjects in the low motivation condition ($F_{1,64} = 4.22$, $p < .05$). Manipulation of argument quality was successful as well, because strong arguments were perceived as stronger than weak arguments (.59 versus -.32; $F_{1,64} = 7.56$, $p < .05$).

Because of factors such as excessive blinking of the eye or tear fluid in the eye, reliability of the eye movement data of 16 subjects was insufficient to include them in further analyses. The remaining 52 subjects were divided among the four conditions in approximately equal numbers.

Study 2

Sample, stimuli, and procedure. One hundred eighteen randomly selected consumers participated in the second study. Twenty-three percent was between 16 and 25 years of

age, 26% was between 26 and 35 years, 30% was between 36 and 45 years, and 21% was 46 years of age or older. Fifty-five men and 63 women participated. The purpose of this study was to provide a more natural exposure situation than in the first experiment, using, in addition, more advanced presentation and eye-tracking instrumentation, examining multiple advertisements, and examining naturally occurring differences in consumer motivation.

On entering, subjects first completed a brief questionnaire assessing sociodemographics and various opinions. The questionnaire contained items about the relevance to consumers of 28 product and service categories. Two items assessed the relevance to consumers of grooming and personal care products: "To me personal care products and cosmetics are..." and "To me clothing and textile goods are...", both accompanied by five-point response scales from "very important" to "very unimportant." Scores on the two items were averaged (coefficient alpha = .70). Four consumer motivation groups ("very low" to "very high") were constructed by categorizing the scores into four quantiles, so that mean motivation scores differed strongly among the four groups. This procedure aims to tap natural differences in enduring involvement (cf. Rosbergen, Pieters, and Wedel 1997), or what Celsi and Olson (1988) call intrinsic sources of personal relevance.

Next, subjects participated in the eye-tracking study. They were seated in front of a 20-inch, touch-sensitive liquid crystal display monitor, on which a computerized magazine appeared. The monitor was built into a table, slightly tilted, to mimic the position in which consumers regularly read magazines. Subjects could page through the magazine at their own pace by touching the lower right (page forward) or left (page backward) of the screen. The magazine contained 50 double pages, both editorial material and new and familiar advertisements. Three advertisements for grooming and personal care products were inserted three times. They pertained to new advertisements for a new brand of toothpaste ("Fluocaril"), an existing brand of personal care products ("Nivea"), and an existing brand of soap products ("Sunlight"). All advertisements contained a headline, body text, packshot, and pictorial, as did the advertisement in Study 1. The advertisements were inserted three times, always with different editorial material facing it. Order of the advertisements was randomized across subjects, with the restrictions that the target advertisements never came in first or last place (to rule out primacy and recency effects) and that two consecutive exposures to the target advertisement were interspersed by at least three unrelated double pages. Subjects were instructed to page freely through the magazines at their own pace, as if at home. The three target advertisements in Study 2 are presented in the top right corner and at the bottom of Figure 1 (advertisements B-D).

While subjects paged through the magazines, their eye movements were recorded with infrared scleral reflection eye-tracking methodology, similar to but more advanced than that used in Study 1. This particular eye-tracking methodology allows subjects to move their heads freely (within a virtual box of approximately 30 centimeters) while paging through the electronic magazine as cameras track the position of both the head and the eye and continuously match the information. The position of the fovea (yellow spot) is measured at 50 hertz. Subjects with glasses received

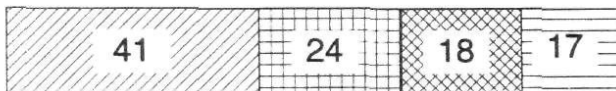
Figure 1

THE FOUR PRINT ADVERTISEMENTS AND THE PREDICTED ATTENTION DISTRIBUTION ACROSS ELEMENTS

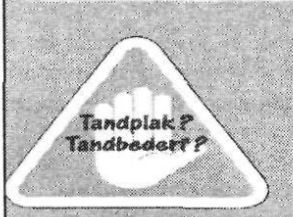
A: Aquavital

AQUAVITAL doet alles voor je haar

De krachtigste extracten in AQUAVITAL shampoo geven je haar een lekkere boost. Het is zacht en ook 20 maal als een 30 maal voedender te gebruiken. Het kan elke dag gebruikt worden. Niets is daarom zo goed voor je haar als iedere dag AQUAVITAL. Het is een shampoo die je haar echt verdient. Ze doet dat Shampoo elke dag alles voor je mooie haar.

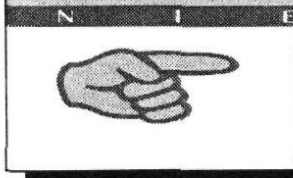


B:Fluocaril

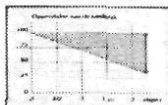


Halt!

**Laat bacteriële plak
uw tanden
niet aanvalen!**



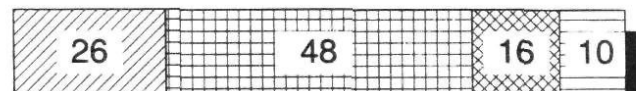
Bacteriële plak: vijand nummer 1 van uw tanden. Vraag en antwoord: ze ze zich vast rio uw tanden. De zure bestanddelen tasten het tandglazuur aan en herbrengen het tandvlees. Tandbedert is niet ver weg. Het loskomen te zitten van de tanden evenwinn. Vochten tegen bacteriële plak is een dagelijks strijd. Met succes bestrijden vraagt om een systematische aanpak. De tanden poetsen na elke maaltijd, de juiste tandborstel kiezen en de juiste tandpasta gebruiken die het profaneus specifiek aanpak. De nieuwe Fluocaril Bacteriële Plak werd speciaal ontworpen om bacteriële tandplak te bestrijden. Het bevat chlorhexidine, een bestanddeel dat het vroege stadium mogelijk maakt om de plak met 35% tot 60% te verminderen. Bescherm uw gebit: bind vanaf vandaag de strijd aan tegen bacteriële plak. Met een heelp discipline. En met Fluocaril Bacteriële Plak.



Bacteriële plak op de tanden
na 14 dagen gebruik van de Fluocaril Bacteriële Plak

VERKOCHT IN DE APOTHEEK





C: Nivea

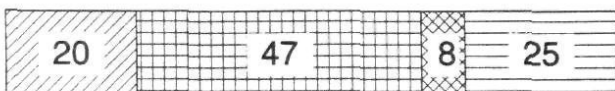
ONTDEK NIVEA *Beauté*.

CIL OPTIMAL. DE MASCARA VOOR VERZORGDE WIMPERS EN EEN BETOVERENDE BLIK.

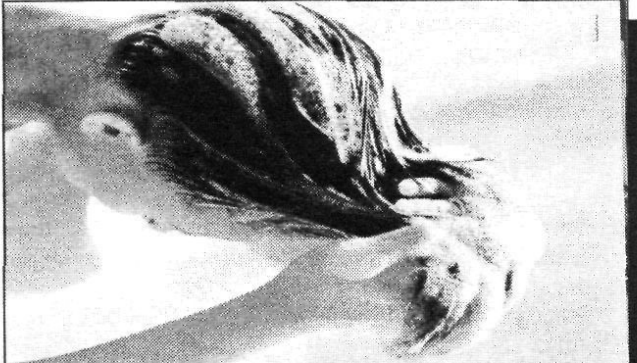
Ontdek het optimale de nieuwe NIVEA Beauté mascara en 24h 3 in 1 werking, maar ook het ruisende experimenteel NIVEA Beauté mascara! Het zijn exclusieve bewijzen dat het NIVEA Beauté mascara echt en verscheidt is. Het ruisende mascara, de enige met ruisende micro-schakels, is de enige met ruisende micro-schakels. Het is de enige met ruisende micro-schakels. Het is de enige met ruisende micro-schakels.

NIVEA *Beauté*

NIVEA *Beauté* VERZORGING KRIJGT KLEUR.



D: Sunlight



Sunlight shampoo, goddelijk zacht,
 luistert men.

Het is de haar kruidenkeacht die met een heel pure en zachte Sunlight shampoo is
 aangemaakt. Het is de heerlijke geur die door haar haars en en polsjes en een heerlijk zacht
 en zacht met een heerlijk tride pH, om haar te beschermen en haar te laten zacht
 en te wassen en verzorgen. Zoals er vries een zacht en zacht glans door haar
 kruidenkeacht haars spreekt, dat zijn het goddelijke.

Een essentieel moment.





 Bodytext

 Headline

 Packshot

☐ Pictorial

special lightweight replacement glasses that allow valid infrared eye tracking. Subjects indicated in the debriefing that they generally felt at ease (94%) and relaxed (97.5%) during the study.

RESULTS

Study 1

Attention duration. The average attention duration in Study 1 was 1.45 seconds for the headline, 1.25 seconds for the pictorial, 4.25 seconds for the text, and 1.04 seconds for the packshot. In Table 1, we present the results of the model tests, and in Table 2, we present the parameter estimates for the best models for attention duration.

Inspection of Table 1 shows that, for Study 1, model [E,R] provides the best representation of the data because it yields the lowest value of the CAIC statistic. This implies that attention duration differs significantly across elements of the advertisement and across repeated exposures. Table 1 shows that neither consumer motivation nor argument quality affects the amount of attention paid to the ad elements, because neither model [E,R,M] nor model [E,R,Q] represents the data better than model [E,R] does. Thus, H_{3a} is not supported, but H_{3b} is.

Parameter estimates for the best model [E,R] in Study 1 are displayed in Table 2. They reveal that attention duration is longest for the body text, followed by the headline, and shortest for the pictorial and the packshot. The percentage difference indicates the difference in gaze duration between the indicated ad element and the packshot (the reference ad element). For example, the attention duration to the body text is three times longer than the attention duration to the packshot. In addition, a progressive decrease in the expected attention duration is observed across exposures, as indicated by the estimates of R(1) and R(2) in Table 1. Attention duration during the first exposure to the advertisement is close to one and a half times longer than during the third exposure. This supports H_1 .

Scanpaths. The average number of fixations on the ad elements was 5.76 for the headline, 3.79 for the pictorial, 15.74 for the body text, and 5.62 for the packshot. In Table 3, we present the results of the model tests, and in Table 4, we present the parameter estimates for attention scanpaths.

The left-hand part of Table 3 presents the results of the model selection procedure for the scanpath models in Study 1. The significant improvement in fit from the first model [-] to the second [O,D] indicates that the selection of fixation points cannot be regarded as completely random. Adding a main effect for repetition to the model significantly improves the model's fit ([O,D,R] versus [O,D]). This supports H_1 , in that attention duration decreases across repeated exposures.

As indicated by the highly significant LR test for the model [OD,R] versus the model [O,D,R] and the associated drop in CAIC, there is strong dependence between successive fixations on ad elements. The overwhelming evidence for a first-order Markov process supports H_{2a} . Reversibility of this process, in turn, requires that the model fit does not decrease significantly when we impose a quasi-symmetric (the model [O,D,S,R]) instead of the unrestricted Markov structure in the model [OD,R] on the interaction of rows and columns of the transition matrices. In Table 1, the compari-

son of these two models shows that the quasi-symmetric model fits the data as well as the unrestricted model and that CAIC is lowest for the quasi-symmetric model. This implies that the scanpath is reversible, which supports H_{2b} .

The inclusion of an interaction effect of ad repetitions and the row and the quasi-symmetry term [OR,D,SR] does not result in a significantly better fit to the data than the benchmark model [O,D,S,R]. This means that the Markov chain is stationary and the stochastic scanpath is stable across repeated exposures of the print advertisement, so H_{2c} is supported. Thus, attention scanpaths in Study 1 obey a first-order, reversible, stationary Markov model.

Finally, neither motivation ([O,D,S,R,M] versus [O,D,S,R]) nor argument quality ([O,D,S,R,Q] versus [O,D,S,R]) significantly affects the number of fixations. In addition, the scanpath is stationary across those conditions, as is shown by the nonsignificant improvement of the models [OM,D,SM,R] and [OQ,D,SQ,R]. Thus, H_4 is supported completely, but H_3 is supported only for argument quality.

Parameter estimates for the selected scanpath model are presented in Table 4. The estimates and t-values show that subjects pay significantly more attention to the advertisement during the first exposure than during subsequent exposures. Furthermore, body text, headline, packshot, and pictorial receive a decreasing amount of attention, in that order. The distribution of the estimated volume of fixations across the four ad elements and across the three exposures is indicated in the bar chart below the target advertisement in Figure 1. Inspection of advertisement A shows that 41% of the estimated number of fixations goes to the body text, 24% to the headline, 18% to the packshot, and 17% to the pictorial. The results of the Markov model for scanpaths corroborate those of the gamma model for attention duration.

As hypothesized, scanpaths of print advertisements can be described by a stationary, reversible, first-order Markov process. Inspection of Table 4 shows that (1) the amount of attention paid to the advertisement decreases by approximately 50% from the first exposure to the third; (2) the majority of saccades, approximately 75%, occur within ad elements, in particular in the body text; (3) most interelement saccades start from or end at the packshot; (4) the expected transition matrices are quasi-symmetric; and (5) the transition probabilities remain constant across exposures and motivation and argument quality conditions. The steady state probabilities of the Markov chain indicate that the probability that the subject's eyes will move to a specific ad element ultimately will equal .19 for the headline, .13 for the pictorial, .50 for the body text, and .18 for the packshot. In Figure 2, we offer the estimated scanpath superimposed on the advertisement. Arrows indicate the directions of saccades. Self-reflecting arrows indicate saccades within ad elements. Inspection of Figure 2 indicates, for example, the higher likelihood of scanning from the packshot to the body text (.21) than the other way around (.07). The high likelihood of saccades within the body text (.89) and the headline (.74), as compared with the pictorial (.55) and the packshot (.50), indicates reading with its associated multiple saccades in a designated space.

Contrary to our expectations, differences in consumer motivation did not translate into differences in attention duration, as indicated by the nonsignificant effect of motivation in the gamma and NBD models. We expect that this re-

Table 1
MODEL TESTS FOR GAZE DURATIONS

Model	Study 1				Study 2			
	Aquavital		Fluocaril		Nivea		Sunlight	
	ln(L)	CAIC	LR (df)	ln(L)	CAIC	LR (df)	ln(L)	LR (df)
I-]	-1050.00	2114.87		-210.60	437.19		551.00	
[E]	-957.39	1951.96	185.23* (3)	-18.02	77.32	385.16* (3)	663.37	220.74* (3)
[E,R]	-922.16	1896.36**	70.46* (2)	15.82	26.14	67.68* (2)	676.67	26.60* (2)
[E,R,M]	-920.40	1900.29	3.52 (1)	38.36	5.83**	45.08* (3)	705.09	56.84* (3)
[E,R,Q]	-920.65	1900.79	3.40 (1)	—	—	—	—	—

*LR test significant at $p < .01$.

**Denotes the minimum CAIC value for that advertisement.

Notes: CAIC = consistent Akaike information criterion, LR = likelihood ratio, and df = degrees of freedom.

Table 2
PARAMETER ESTIMATES FOR GAZE DURATIONS

Model	Study 1				Study 2			
	Aquavital		Fluocaril		Nivea		Sunlight	
	Estimate	t-value	Percentage Difference	Estimate	t-value	Percentage Difference	Estimate	Percentage Difference
Intercept	-.409	-4.22	—	-1.795	-16.37	—	-2.375	—
E(headline)	.311	2.68	36%	1.474	14.05	337%	1.401	306%
E(pictorial)	.201	1.75	22%	-.690	-6.57	-50%	.640	90%
E(body text)	1.378	11.88	297%	.419	3.99	52%	-.139	-13%
R(1)	.861	8.52	137%	.752	8.26	112%	.463	59%
R(2)	.382	3.82	47%	.485	5.33	62%	.284	33%
M(1)	—	—	—	.567	5.33	76%	.744	110%
M(2)	—	—	—	.459	4.35	58%	.634	89%
M(3)	—	—	—	.030	.30	3%	.241	27%
Lambda	-.039	-83	—	-.658	-21.16	—	-.719	—

Table 3
MODEL TESTS FOR SCANPATHS

Model	Study 1				Study 2			
	Aquavit		Fluocaril		Nivea		Sunlight	
	ln(L)	CAIC	LR (df)	ln(L)	CAIC	LR (df)	ln(L)	CAIC
[—]	—786.53	1585.57	—	—727.56	1467.63	—	—652.41	1317.34
[O,D]	—767.17	1565.64	19.36* (3)	—675.25	1381.79	104.62* (3)	—578.53	1188.34
[O,D,R]	—760.72	1565.24	6.45* (2)	—666.85	1377.50	16.80* (2)	—566.80	1177.41
[O,D,R]	—645.96	1392.03	229.52* (9)	—588.53	1277.19	156.64* (9)	—470.14	1040.40
[O,D,S,R]	—647.67	1376.69**	3.42 (3)	—592.05	1265.45**	7.04 (3)	—472.01	1025.37
[O,D,S,R,M]	—644.83	1483.63	5.68 (18)	—585.46	1364.91	13.18 (18)	—463.12	1120.23
[O,D,S,R,M]	—647.57	1382.75	20 (1)	—590.00	1280.11	4.10 (3)	—455.43	1010.98**
[O,M,D,SM,R]	—643.43	1430.77	8.28 (9)	—578.08	1425.21	23.84 (27)	—437.20	1143.46
[O,D,S,R,Q]	—647.13	1381.87	1.08 (1)	—	—	—	—	—
[OQ,D,SQ,R]	—644.13	1432.18	6.00 (9)	—	—	—	—	—

*LR test significant at $p < .01$.

**Denotes minimum CAIC for that advertisement.

Notes: CAIC = consistent Akaike information criterion, LR = likelihood ratio, and df = degrees of freedom.

Table 4
PARAMETER ESTIMATES FOR SCANPATHS

Model	Study 1			Study 2		
	Aquavit		t-value	Fluocaril		t-value
	Estimate	Estimate		Estimate	Estimate	
Intercept	.640	.640	2.75	2.376	.139	.61
E(headline)	.241	.241	1.59	1.105	1.775	15.75
E(pictorial)	—0.092	—0.092	—61	—525	1.141	9.86
E(body text)	.802	.802	5.28	.487	.965	8.26
R(1)	.624	.624	4.27	.673	.778	8.78
R(2)	.283	.283	1.91	.495	.268	2.88
M(1)	—	—	—	—	.562	5.42
M(2)	—	—	—	—	.193	1.82
M(3)	—	—	—	—	.366	3.46
S(headline, pictorial)	—1.637	—1.637	—7.18	—2.004	—1.213	—11.36
S(headline, body text)	—4.406	—4.406	—15.35	—2.192	—1.678	—13.95
S(headline, packshot)	—1.487	—1.487	—6.61	—2.146	—1.244	—7.58
S(pictorial, body text)	—2.425	—2.425	—10.50	—1.319	—1.853	—12.25
S(pictorial, packshot)	—1.137	—1.137	—5.03	—673	—1.274	—6.59
S(body text, packshot)	—1.764	—1.764	—7.98	—1.429	—1.279	—6.26
nu	—1.953	—1.953	—18.78	.611	2.566	9.84

Sunlight

Nivea

Fluocaril

Aquavit

Estimate

t-value

r-value

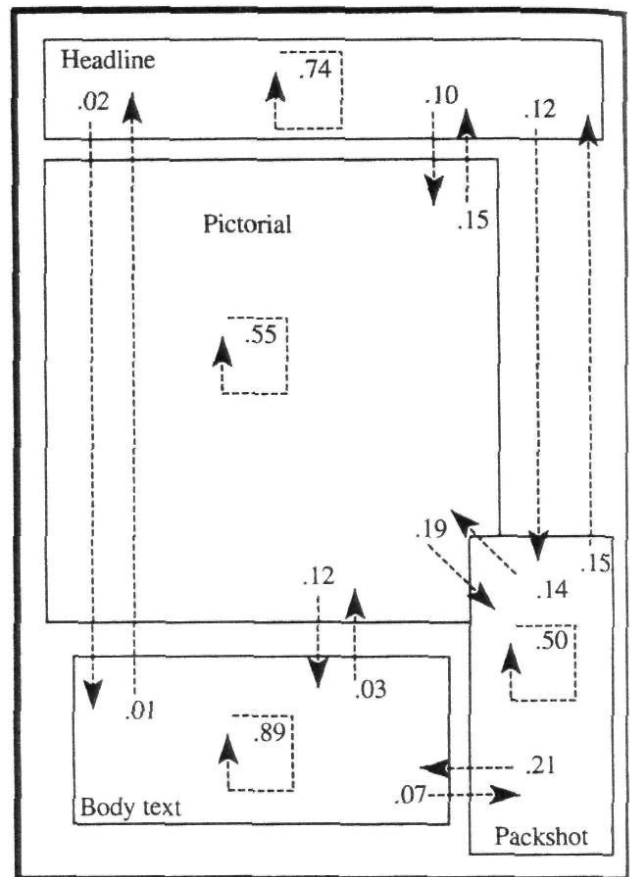
Figure 2

PRINT ADVERTISEMENT (A) AND ITS SCANPATH CHARACTERIZED BY CONDITIONAL TRANSITION PROBABILITIES (B)

AQUAVITAL doet alles voor je haar



De toegevoegde extracten in AQUAVITAL shampoo geven je haar een lekkere geur. Het is zowel in een 200ml. als een 300ml. verpakking te verkrijgen. Het kan door iedereen gebruikt worden. Niets is daarom zo goed voor je haar als iedere dag AQUAVITAL. Het is een shampoo die je haar echt verdient. Zo doet deze shampoo elke dag alles voor je mooie haar.

sult is, at least partly, due to the overall high levels of attention in Study 1. Note that the average attention duration in Study 1 is significantly longer than what is reported in attention research conducted in more natural conditions (cf. Kroeber-Riel 1993; Rosbergen, Pieters, and Wedel 1997; Rossiter and Percy 1997, p. 295). Study 2 was designed to examine this issue in more detail. It studies attention to print advertising in more natural conditions, using naturally occurring differences in consumer motivation.

Study 2

Attention duration. The average attention duration to the advertisements in Study 2 across the three repetitions was 2.53 seconds for Fluocaril, 1.52 seconds for Nivea, and 1.42 seconds for Sunlight, which is much shorter than in Study 1. The issue is whether the hypotheses are supported in the more natural conditions in this study. The model tests are found in Table 1, the parameter estimates of the selected model in Table 2.

In Study 2, model [E,R,M] provides the best representation of the data for all three advertisements; the CAIC of this model is lowest. This implies that, for all three advertisements, attention duration differs between ad elements (E), attention duration decreases significantly over time (R), and significant differences between consumer motivation groups are observed (M). These results support H_1 and H_{3a} . The at-

tention decrement from the first to the third exposure to the advertisements is substantial: for Fluocaril from 3.49 seconds to 1.58 seconds, for Nivea from 2.11 seconds to 1.04 seconds, and for Sunlight from 1.67 seconds to 1.16 seconds. On average, the print advertisements receive approximately 55% of the attention during their third exposure compared with their first exposure. The attention decrement is similar to that in Study 1. Inspection of Table 2 further shows that, in all three advertisements, the headline receives most attention—in the case of the Nivea advertisement, almost eight times more than the packshot. The pictorials of the Nivea and Sunlight advertisement receive more attention than their respective packshots, but the pictorial of the Fluocaril advertisement receives approximately 50% less attention than its packshot.

Table 2 also reveals significant differences between consumer motivation groups in attention duration. For all three advertisements, attention duration from the lowest to the highest consumer motivation group increases significantly. Compared with the lowest motivation group, the highest motivation group pays 76% more attention to the Fluocaril advertisement, 85% more attention to the Nivea advertisement, and 110% more attention to the Sunlight advertisement. Finding a significant attention decrement across ad repetitions, significant differences between consumer motivation groups, and substantial heterogeneity in attention du-

ration across the three advertisements would make universal support for the scanpath hypotheses even more telling. That issue is addressed next.

Scanpaths. In Table 3, we present the results of the tests for the scanpath models for Study 2. As in Study 1, there is a significant improvement in fit from the first model [–] to the second [O,D] for all three print advertisements. This provides strong support against a completely random selection of fixation points. As indicated by the significant improvement of the model, including the repetition effect ([O,D,R] versus [O,D]), the number of fixations on each of the three advertisements drops significantly across ad repetitions, as in Study 1. This supports H_1 and corroborates the findings of the gamma model for attention duration.

As indicated by the highly significant LR test for the model [OD,R] versus the model [O,D,R] and the associated drop in CAIC, there is clear evidence for a first-order Markov process in attention scanpaths for all three advertisements. This supports H_{2a} . Reversibility of the scanpath is supported as well, because for all three advertisements, the model fit does not decrease significantly when we impose a quasi-symmetric instead of an unrestricted Markov structure (model [O,D,S,R] versus model [OD,R]). The CAIC of the quasi-symmetric model is better for each of the three advertisements. This implies that the scanpath is reversible and that Study 2, as did Study 1, supports H_{2b} .

The interaction of ad repetitions with the row effect and with the quasi-symmetric Markov structure (model [O,D,S,R] versus model [OR,D,SR]) does not lead to a better fit to the data for each of the three advertisements, as is indicated by an increase in the CAIC and nonsignificant LR tests. This shows that the stochastic scanpath is stationary across exposures, so that, as in Study 1, H_{2c} is supported for all three advertisements.

Motivation significantly affects the fixation frequencies for two of the three advertisements (Nivea and Sunlight, [O,D,S,R,M] versus [O,D,S,R]), though this is not the case for Fluocaril, for which the CAIC is lowest for the model [O,D,S,R]. This diverges from the findings for gaze duration for that brand, but we conclude that there is some support for H_{3a} .

As predicted, the interaction between consumer motivation and the quasi-symmetric Markov structure is insignificant for all three advertisements ([O,D,S,R,M] versus [OM,D,SM,R]), as is indicated by the CAIC, which is lowest for the former model. This shows that the attention scanpath is stationary across consumer motivation groups for all three advertisements, which supports H_4 .

The models with the lowest CAIC are selected for further inspection: model [O,D,S,R] for Fluocaril and model [O,D,S,R,M] for Nivea and Sunlight. Inspection of the parameter estimates in Table 4 shows that (1) the headline receives most attention, followed by the pictorial for two of the three advertisements (Nivea and Sunlight), and by the body text for the other (Fluocaril); (2) most interelement saccades start from or end at the headline; (3) the transition matrices are quasi-symmetric; and (4) the scanpath remains unchanged across repeated exposures and consumer motivation groups. In both studies, there is strong evidence of a scanpath that is stable across repeated exposures to the same advertisement and across degrees of consumer involvement. These results were obtained across advertisements with dis-

tinct scanpaths and attention duration, which supports their credibility. In Figure 1, advertisements B–D, the distribution of estimated fixations across the ad elements is indicated in the bar charts below the target advertisements. For example, 47% of the estimated fixations on the Nivea advertisement go to the headline, 25% to the pictorial, 20% to the body text, and 8% to the packshot.

DISCUSSION

To our knowledge, this is the first investigation in which attention duration and attention scanpaths to print advertising are examined jointly and in detail. We propose a gamma regression model for attention duration and a Markov NBD model for attention scanpaths. The duration and scanpath models were applied in two studies to examine consumers' visual attention to repeated advertisements using eye-tracking methodology.

The results provide strong support for predictions derived from scanpath theory. In support of H_1 , we found in both studies that repetition reduced the amount of attention paid to the advertisement and its elements by approximately 50% from the first to the third exposure.

In support of H_2 , repeated exposure to advertisements did not change the order in which ad elements were scanned in either Study 1 or Study 2. In particular, as predicted by scanpath theory, we established the existence of attention scanpaths that can be described adequately by a stationary, reversible, first-order Markov process. The stability of the stochastic scanpath across repeated exposures is particularly striking, because it indicates that the pattern according to which consumers scan print advertisements is determined largely during the first exposure and is difficult to change during subsequent exposures to the same advertisement. We do not claim that scanpaths are deterministically identical across consumers and ad repetitions. Our Markov NBD model for the scanpaths is a stochastic model that allows random variations in the saccade pattern across subjects and exposures. We allow for heterogeneity in the transition probabilities across subjects through a gamma distribution of those probabilities. That distribution deals with random variation of the scanpath across consumers. Thus, both studies show that stable scanpaths exist across subsequent exposures to advertisements, though they take random variation of the scanpaths across individuals into account.

In support of H_3 , differences in argument quality in Study 1 did not lead to differences in attention duration. The results presented further indicate that the quality of the arguments in the advertisement does not postpone satiation, because argument quality does not moderate the effect of repetition on any aspect of visual attention. It appears that when consumers believe they "know" or have seen the advertisement before, subsequent exposures stimulate identification responses, which lead to reductions in the duration of attention, as is conjectured by Krugman (1972). Although variations in advertisement executions may raise attention to the levels attained during the first exposure (Haugtvedt et al. 1994), strong arguments in our research did not keep attention at that level.

Counter to H_3 , differences in consumer motivation had no effect on attention duration or fixation frequency in Study 1, but they did have strong effects on attention duration for all three advertisements in Study 2, though the effect on fixa-

tion frequency was significant for two of three advertisements only. We do not expect that the absence of a motivation effect on attention duration in Study 1 is due to an insufficiently strong motivation manipulation, because manipulation checks were statistically significant. It is more likely that the absence of such an effect in Study 1 is due to a ceiling effect on attention duration. The average attention duration across motivation conditions and ad repetitions in Study 1 was almost 8 seconds, which is significantly higher than the 1.82 seconds for the three advertisements in Study 2 and higher than what is usually reported in attention research in natural conditions (cf. Kroeber-Riel 1993). We expect that the data collection procedure in Study 1 and the fact that a new advertisement for a new brand was used raised consumer motivation from high to very high instead of from low to high. With such extremely high levels of motivation, differences in attention duration apparently could not be identified. In Study 2, in more natural exposure conditions, the hypothesized motivation effect on attention duration consistently emerged for all three advertisements, and it emerged on fixation frequency for the two advertisements for existing brands (Nivea and Sunlight). In a setting akin to our Study 2, Rosbergen, Pieters, and Wedel (1997) find significant differences in attention duration between consumers who differed in motivation for an existing brand of shampoo. In summary, our results show that naturally occurring differences in intrinsic sources of consumer motivation (Celsi and Olson 1988) affect the duration of visual attention to print advertisements. The results suggest that differences in attention duration due to consumer motivation may be attenuated quickly by increased levels of overall attention, which are stimulated by characteristics of the exposure situation and the stimuli used. Finally, in support of H_4 , neither consumer motivation nor argument quality affected attention scanpaths.

Our results attest to the importance of attention in understanding the mechanisms underlying advertising effectiveness and wear-out. The finding that attention duration dropped by nearly 50% over three repeated exposures (while the scanpath itself remained stable) indicates that, if consumers control exposure duration themselves, such as with print or electronic advertising, they may adapt exposure duration to limit satiation. The results show how quickly attention wear-out for print advertising can take place. To date, most repetition research has focused on acceptance wear-out. Such research typically has been conducted with fixed and rather long exposure durations to the advertisements. In such conditions, satiation may set in rapidly, and consumers' attitude toward the advertisement may drop significantly across only a few repetitions. Although we did not measure ad liking in this study and despite our finding that attention duration drops consistently, even when the initial exposure duration is already very low (a few seconds only), we warn against concluding prematurely that advertising repetitions have fast and strong negative effects on ad liking. The first instrument that consumers can use to manage repeated exposure to advertisements is reducing the duration of their attention (see also Chatterjee, Hoffman, and Novak 1998). When consumers can control their exposure to advertising through paging, zapping, zipping, or clicking a mouse button, acceptance wear-out may be more an exception and attention wear-out the rule.

A potential limitation of this research is the relatively short intervals (i.e., less than an hour) between ad exposures, which may have led to sharper attention duration decrease and higher stability of the attention scanpaths than in real settings. However, we confirmed the existence of stable scanpaths in two studies with different design and different length of the intervals between exposures. Moreover, our results are directly relevant for impact scheduling, that is, repeating the same advertisement multiple times within the same print issue or commercial block, which is a common media strategy. In addition, our research setting is a typical pretest situation to examine the quality of a new advertisement and the impact of repeating the advertisement several times within a short time frame, and interexposure intervals are similar to those used in previous studies on advertising repetition (Cacioppo and Petty 1979, 1980; Ray and Sawyer 1971; Schumann, Petty, and Clemons 1990). Moreover, basic research on scanpath theory finds similarly stable effects across exposure durations of up to a week (Stark 1994).

In summary, strong evidence for attention wear-out was found, as well as significant differences between consumers who differed in motivation. Strong support also was found for the existence of attention scanpaths that are stable across advertising repetitions and consumer and message characteristics.

Further Research

Replication of this study should use advertisements for different products placed in several advertising media; television and electronic advertisements are particularly interesting because of their inherent complexity. Several of our hypotheses may carry directly over to those media, but we leave it for additional research to provide the theoretical underpinnings and empirical support.

Further research might examine the effect of media planning tactics, such as bursting, and the effect of interexposure intervals on attention wear-out. Although multiple exposures within a short duration in different media vehicles (bursting) also may lead to substantial drops in attention, attention gradually may return close to its original level after the burst. Additional research that examines the impact of actual versus experienced exposure frequency on visual attention to advertising appears particularly worthwhile. Attention wear-out may be more due to self-reported than to actual prior exposure frequency, and perhaps they have independent effects.

Another potential avenue for further research pertains to the determinants of attention scanpaths. Attention scanpaths are likely to be the joint outcome of (1) consumers' goals and the cognitive schemata they have about the dominant architecture of print advertisements in general in a specific medium or for a specific product/brand and (2) specific ad characteristics that attract and guide attention, such as color, contrast, letter and picture size, and so forth. Suggestive evidence for the former indicates that people almost instantaneously form spatial models of stimuli, considered primitive precognitive models, and that they use these mental representations to scan new stimuli. When the mental representation of the stimulus changes, the attention scanpath changes (Stark and Ellis 1981).

The result that minimal differences in scanpaths were present across subject characteristics, whereas the ad layout

(headline, pictorial, packshot, body text) exerted strong effects, suggests that data- or stimulus-driven processes are important and perhaps dominant in the scanning instructions in our research. To date, virtually no systematic research has been performed on the interplay between advertisement and consumer characteristics in attention processes, despite the key importance ascribed to it in advertising research (Batra, Myers, and Aaker 1996; Kroeber-Riel 1993; Rossiter and Percy 1997). In Study 1, the body text received the most attention, followed by the headline. In Study 2, the headline received the most attention for each of the three advertisements, and the body text received much less attention. As yet, we cannot determine whether the difference between studies in attention to the body text and headline is due to differences in ad layout, differences in exposure conditions, or other factors. However, compared with Study 1, the attention duration in Study 2 was substantially shorter, and recent research suggests that when consumers spend less time on commercial stimuli, attention to the textual information suffers most (Pieters and Warlop 1999). The results of Study 2 appear more typical and converge with print copy principles that emphasize that "Since most people reading print ads never go beyond the headline, it is also extremely important that the headline and visual complement each other so well and 'tell the story' so easily, that a reader who only looks at the headline and main visual can 'get the message' without having to read a word of the body copy" (Batra, Myers, and Aaker 1996, p. 425). Further research might build on our findings and on the model of visual attention that we developed here. Research in which architectures of advertisements (i.e., size and location of headline, pictorial, body text, and packshot; cf. Rosbergen, Pieters, and Wedel 1997) and conditions of consumers are varied systematically will provide insight into the relative importance of person- versus stimulus-specific determinants of attention duration and scanpaths.

A final important question is whether certain scanpaths contribute more to advertising effectiveness than others. Assuming equal attention duration, does it matter how, for example, a consumer scans two different advertisements? According to scanpath theory, the scanpath facilitates subsequent recognition of advertisements and thus of advertised brands. Perhaps some scanpaths even stimulate message learning and attitude formation more than others. Additional research that examines both regularities in eye movements and the effects of such regularities on subjects' cognitive responses, memory, and attitudes appears particularly worthwhile.

REFERENCES

- Agresti, Alan (1990), *Categorical Data Analysis*. New York: John Wiley & Sons.
- Anand, Punam and Brian Sternthal (1990), "Ease of Message Processing as a Moderator of Repetition Effects in Advertising," *Journal of Marketing Research*, 27 (August), 345-53.
- Aptech (1992), *Gauss Applications Manual: Maximum Likelihood*. Maple Valley: Aptech, Systems Inc.
- Axelrod, Joel N. (1980), "Advertising Wear-Out," *Journal of Advertising Research*, 20 (October), 13-18.
- Batra, Rajeev, John G. Myers, and David A. Aaker (1996), *Advertising Management*, 5th ed. Upper Saddle River, NJ: Prentice Hall.
- and Michael L. Ray (1986), "Situational Effects of Advertising Repetition: The Moderating Influence of Motivation, Ability, and Opportunity to Respond," *Journal of Consumer Research*, 12 (March), 432-45.
- Belch, George E. (1982), "The Effects of Television Commercial Repetition on Cognitive Response and Message Acceptance," *Journal of Consumer Research*, 9 (June), 56-65.
- Berger, Ida E. and Andrew A. Mitchell (1989), "The Effect of Advertising on Attitude Accessibility, Attitude Confidence, and the Attitude-Behavior Relationship," *Journal of Consumer Research*, 16 (December), 269-79.
- Bozdogan, H. (1987), "Model Selection and Akaike's Information Criterion (AIC): The General Theory and Its Analytical Extensions," *Psychometrika*, 52, 345-70.
- Cacioppo, John T. and Richard E. Petty (1979), "Effects of Message Repetition and Position on Cognitive Responses, Recall, and Persuasion," *Journal of Personality and Social Psychology*, 37, 97-109.
- and — (1980), "Persuasiveness of Communications is Affected by Exposure Frequency and Message Quality: A Theoretical and Empirical Analysis of Persisting Attitude Change," in *Current Issues and Research in Advertising*, James H. Leigh and Claude R. Martin, eds. Ann Arbor, MI: University of Michigan, 97-122.
- Calder, Bobby J. and Brian Sternthal (1980), "Television Commercial Wear-Out: An Information Processing View," *Journal of Marketing Research*, 17 (May), 173-86.
- Celsi, Richard L. and Jerry C. Olson (1988), "The Role of Involvement in Attention and Comprehension Processes," *Journal of Consumer Research*, 15 (September), 210-24.
- Chatterjee, Patrali, Donna L. Hoffman, and Thomas P. Novak (1998), "Modeling the Clickstream: Implications for Web-Based Advertising Efforts," Project 2000 Manuscripts, Vanderbilt University, Nashville (available at URL: <http://www2000.ogsm.vanderbilt.edu/papers/clickstream/clickstream.html>).
- Cox, Dena S. and Anthony D. Cox (1988), "What Does Familiarity Breed? Complexity as a Moderator of Repetition Effects in Advertisement Evaluation," *Journal of Consumer Research*, 15 (June), 111-16.
- Craig, C. Samuel, Brian Sternthal, and Clark Leavitt (1976), "Advertising Wear-Out: An Experimental Analysis," *Journal of Marketing Research*, 13 (November), 365-72.
- Ellis, Stephen R. and James Darrell Smith (1985), "Patterns of Statistical Dependency in Visual Scanning," in *Eye Movements and Human Information Processing*, Rudolf Groner et al., eds. Amsterdam: Elsevier Science Publishers BV, 221-38.
- Greenwald, Anthony G. and Clark Leavitt (1984), "Audience Involvement in Advertising: Four Levels," *Journal of Consumer Research*, 11 (June), 581-92.
- Groner, Rudolf (1988), "Eye Movements, Attention and Visual Information Processing: Some Experimental Results and Methodological Considerations," in *Eye Movement Research: Physiological and Psychological Aspects*, Gerd Lüer et al., eds. Toronto: C.J. Hogrefe, 295-319.
- and Christine Menz (1985), "The Effect of Stimulus Characteristics, Task Requirements and Individual Differences on Scanning Patterns," in *Eye Movements and Human Information Processing*, Rudolf Groner et al., eds. Amsterdam: Elsevier Science Publishers BV, 239-50.
- Hagtvedt, Curtis P., David W. Schumann, Wendy L. Schneier, and Wendy L. Warren (1994), "Advertising Repetition and Variation Strategies: Implications for Understanding Attitude Strength," *Journal of Consumer Research*, 21 (June), 176-89.
- Janiszewski, Chris (1993), "Preattentive Mere Exposure Effects," *Journal of Consumer Research*, 20 (December), 376-92.
- Kroeber-Riel, Werner (1993), *Bild Kommunikation: Imagerystrategie für die Werbung*. München: Franz Vahlen Verlag.
- Krugman, Dean M., Richard J. Fox, James E. Fletcher, Paul M. Fischer, and Tina H. Rojas (1994), "Do Adolescents Attend to Warnings in Cigarette Advertising? An Eye-Tracking Ap-

- proach," *Journal of Advertising Research*, 34 (November/December), 39-52.
- Krugman, Herbert E. (1972), "Why Three Exposures May Be Enough," *Journal of Advertising Research*, 4, 298-303.
- Lindsey, James K. (1995), *Modeling Frequency and Count Data*. New York: Oxford University Press.
- McCullagh, P. and J.A. Nelder (1989), *Generalized Linear Models*, 2d ed. London: Chapman & Hall.
- Miniard, Paul W., Sunil Bhatla, Kenneth R. Lord, Peter R. Dickson, and H. Rao Unnava (1991), "Picture-Based Persuasion Processes and the Moderating Role of Involvement," *Journal of Consumer Research*, 18 (June), 92-107.
- Molnar, François and Demitrios Ratsikas (1987), "Some Aesthetic Aspects of Visual Exploration," in *Eye Movements: From Physiology to Cognition*, J. K. O'Regan and A. Levy-Schoen, eds. Amsterdam: North Holland, 363-74.
- Noton, D. and Lawrence Stark (1971), "Scanpaths in Eye Movements During Pattern Perception," *Science*, 171, 308-11.
- Pechmann, Cornelia and David W. Stewart (1989), "Advertising Repetition: A Critical Review of Wear-In and Wear-Out," *Current Issues and Research in Advertising*, 11, 285-329.
- Petty, Richard E., John T. Cacioppo, and David W. Schumann (1983), "Central and Peripheral Routes to Advertising Effectiveness: The Moderating Role of Involvement," *Journal of Consumer Research*, 10 (September), 135-46.
- Pieters, Rik G.M. and Luk Warlop (1999), "Visual Attention During Brand Choice," *International Journal of Research in Marketing*, forthcoming.
- Ray, Michael L. and Alan G. Sawyer (1971), "Repetition in Media Models: A Laboratory Technique," *Journal of Marketing Research*, 8 (February), 20-29.
- Rayner, Keith (1995), "Eye Movements and Cognitive Processes in Reading, Visual Search, and Scene Perception," in *Eye Movement Research: Mechanisms, Processes and Applications*, John M. Findlay et al., eds. Amsterdam: Elsevier Science Publishers BV, 3-22.
- Rethans, Arno J., John L. Swasy, and Lawrence J. Marks (1986), "Effects of Television Commercial Repetition, Receiver Knowledge, and Commercial Length: A Test of the Two-Factor Model," *Journal of Marketing Research*, 23 (February), 50-61.
- Rosbergen, Edward, Rik G.M. Pieters, and Michel Wedel (1997), "Visual Attention to Advertising: A Segment-Level Analysis," *Journal of Consumer Research*, 24 (3), 305-14.
- Ross, Sheldon (1996), *Stochastic Processes*, 2d ed. New York: John Wiley & Sons.
- Rossiter, John R. and Larry Percy (1983), "Visual Communication in Advertising," in *Information Processing Research in Advertising*, Richard Jackson Harris, ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 83-125.
- and ——— (1997), *Advertising Communications and Promotion Management*, 2d ed. New York: McGraw-Hill.
- Schumann, David W., Richard E. Petty, and D. Scott Clemons (1990), "Predicting the Effectiveness of Different Strategies of Advertising Variation: A Test of the Repetition-Variation Hypothesis," *Journal of Consumer Research*, 17 (September), 192-202.
- Shanteau, James (1983), "Cognitive Psychology Looks at Advertising: Commentary on a Hobbit's Adventure," in *Information Processing Research in Advertising*, Richard Jackson Harris, ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 153-66.
- Stark, Lawrence W. (1994), "Sequences of Fixations and Saccades in Reading," in *Eye Movements in Reading*, Jan Ygge and Gunnar Lennerstrand, eds. Tarrytown, NY: Elsevier Science Inc, 151-63.
- and Henry C. Ellis (1981), "Scanpaths Revisited: Cognitive Models Direct Active Looking," in *Eye Movements: Cognition and Visual Perception*, Dennis F. Fisher et al., eds. Hillsdale, NJ: Lawrence Erlbaum Associates, 193-226.
- Unnava, H. Rao and Robert E. Burnkrant (1991), "An Imagery-Processing View of the Role of Pictures in Print Advertisements," *Journal of Marketing Research*, 28 (May), 226-31.
- Viviani, Paolo (1990), "Eye Movements in Visual Search: Cognitive, Perceptual and Motor Control Aspects," in *Eye Movements and their Role in Visual and Cognitive Processes*, E. Kowler, ed. Amsterdam: Elsevier Science Publishers BV, 353-93.
- Young, Laurence R. and David Sheena (1975), "Eye-Movement Measuring Techniques," *American Psychologist*, 30 (March), 317-30.

Copyright of *Journal of Marketing Research* (JMR) is the property of American Marketing Association and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.