

**DO WE KNOW WHAT WE LOOK AT?
AN EYE-TRACKING STUDY OF
VISUAL ATTENTION AND MEMORY FOR BRANDS
AT THE POINT OF PURCHASE**

by

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2002/60/MKT

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Printed at INSEAD, Fontainebleau, France.

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Version submitted to Journal of Consumer Research, May 11, 2002

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Abstract

This research examines the link between visual attention and memory for brands at the point of purchase. This is of interest to marketers, who rely on brand recall scores to measure the effectiveness of their point-of-purchase advertising, and to researchers, who often use memory data to study consumer attention. Two studies track the eye movements of consumers while they choose a brand from a supermarket shelf display and measure aided and unaided brand recall shortly thereafter. Study 1 shows that brand recall is overwhelmingly driven by brand familiarity and only to a limited extent by whether the brand was actually looked at or not during the choice task. Study 2 shows that brand recall cannot be used as a proxy for attention to the brand, as even large differences in attention across stimuli, consumers, and brands cannot be inferred from recall data. This research also shows that a single eye fixation can create indirect priming effects, inhibiting or enhancing the recall of related brands depending on the relative accessibility in memory of the primed and target brands. Finally, this research shows that some well-established findings from advertising research do not extend to memory for brands at the point of purchase. In particular, the studies found no primacy effect, no decay effect, a reverse recency effect, and a reverse mirror effect.

In an era of integrated communication, marketers use all points of contact with their customers to increase brand awareness. Building brand awareness is particularly important at the point of purchase because it helps to break through the clutter of products (Drèze, Hoch, and Purk 1994) and because it influences the prestige of the advertised brand and the evaluation of the category assortment (Broniarczyk, Hoyer, and McAlister 1998; Buchanan, Simmons, and Bickart 1999). In this context, it is not surprising that the point of purchase is increasingly viewed as an advertising medium and that point-of-purchase (P-O-P) advertising has become the fifth largest advertising budget expenditure (Najjar 2001).

Marketers typically rely on brand recall scores to gauge the effectiveness of their P-O-P advertising, such as brand packaging, in-store displays, or shelf signage (POPAI-AISM 1994). A key issue for them is to estimate the extent to which these recall scores are driven by consumer in-store attention and not by brand familiarity, competitive interference or category structure effects. If brand recall data are not reliably linked with point-of-purchase attention, marketers may consider using eye-tracking data to measure the ability of their P-O-P advertising to attract consumer attention at the point of purchase. This would be akin to the use of measures such as recall of an advertisement to specifically examine the effect of media advertising rather than more general measures such as brand awareness (Lehmann and Winer 2002).

More generally, studying the link between attention and memory for brands at the point of purchase has implications for the debate on the value of using memory data rather than process-tracing data to study consumer attention. Because of its convenience, memory data have been used to infer attention to a variety of objects, including supermarket prices (e.g., Dickson and Sawyer 1990), product warnings (e.g., Barlow and Wogalter 1993), animate and inanimate objects (Roskos-Ewoldsen and Fazio 1992), and brand names in print ads, television commercials, and brand by attribute matrices (e.g., Finn 1988; Osselaer and Alba 2000). Market research firms

similarly often use memory tests to infer the attention-getting impact (and not just the memory impact) of brand packages or ads (Valiente 1973). For example, starch “noted” score of exposure to print ads measures, in fact, the proportion of respondents who recall having looked at the ad.

To date, the link between attention and memory has only been studied in the context of advertising and the recommendations of this literature have been mixed. For print ads, the use of memory data as a proxy for attention was validated by Krugman et al. (1994) but rejected by Wedel and Pieters (2000). For television commercials, a review by Reeves, Thorson, and Schleuder (1986) recommends combining memory methods with reaction time tasks and neural measures of mental activity. In addition, the amount and pattern of visual information acquisition at the point of purchase is qualitatively different from attention to brands in ads because it is more goal-oriented and occurs under more time pressure (Janiszewski 1998; Pieters and Warlop 1999). Second, brand packages and P-O-P advertising contain less information, are less original, and are more familiar than print or television ads, three factors that weaken the link between attention and memory (Pieters, Warlop, and Wedel 2001). These arguments suggest that even some of the most robust memory effects documented in the context of attention to ads, such as serial order effects, timing effects, and category structure effects, may not hold at the point of purchase.

The purpose of this research is to examine the link between visual attention to brands and consumer memory for these brands at the point of purchase. It follows the spirit of the work of Pieters and colleagues on visual attention and memory for brand in an advertising context (Pieters and Bijmolt 1997; Rosbergen, Pieters, and Wedel 1997; Wedel and Pieters 2000). In the first section of the paper, I develop a set of hypotheses on the effect of attention, category structure, and the type of external retrieval cues on brand recall. In the second section, I test these hypotheses by tracking the eye movements of consumers while they are choosing a brand from a supermarket shelf display and by collecting unaided (category-cued) and aided (brand-cued) brand recall

shortly thereafter. In the third section, I examine whether recall can be used as a proxy for attention by studying, in a different category, whether large differences in attention across stimuli, consumers, and brands can be inferred from brand recall data. In the last section, I summarize key findings and examine their implications for measuring the effectiveness of P-O-P advertising and for the value of memory data in attention research.

MEMORY FOR BRANDS AT THE POINT OF PURCHASE

According to spreading-activation models of memory, brand recall is a function of three factors (Anderson 1983; Nedungadi 1990). First, it depends on the strength of activation of the brand node, which is influenced by consumer familiarity with the brand. In fact, brand familiarity is typically the strongest predictor of brand recall in a variety of tasks and contexts (Kent and Allen 1994; Pieters and Bijmolt 1997). Second, it depends on the availability of retrieval cues, which is influenced by visual attention to the brand and by the type of external cues provided at retrieval (Tulving and Thomson 1973). Third, it depends on the strength of the association between the brand node and other active nodes, which is influenced by the semantic structure of the category (Hutchinson, Raman, and Mantrala 1994). In the following sections, I examine the effect of visual attention, category structure, and the type of external retrieval cues (brand names vs. category name) on memory for brands at the point of purchase.

Visual attention effects

Visual attention to complex stimuli such as supermarket shelf displays can be inferred from the eye movements of consumers. Eye movements consist of fixations (during which the eye remains relatively still for about 200-300 milliseconds) separated by rapid movements, called saccades, which average 3-5° in distance (measured in degrees of visual angle) and last 40 to 50 milliseconds. Attention can be directed without eye movements to stimuli located outside the central 2° of vision of the visual field (called the fovea). However, the location of the fovea during

the eye fixation is a good indicator of visual attention for complex stimuli because (1) little complex information can be extracted during saccades, (2) foveal attention is more efficient than parafoveal attention, and (3) visual acuity deteriorates rapidly outside the fovea (Rayner 1998).

Several studies have shown that eye fixations increase memory for the fixated object, whether it is a picture (Loftus, Hoffman, and Loftus 1999; Loftus 1972), a print ad and the information it contains (Krugman et al. 1994; Pieters et al. 2001; Rosbergen et al. 1997), or a television commercial (Thorson and Zao 1997). Many eye-tracking studies distinguish between noting (making at least one eye fixation) and gaze duration (the total time spent looking at the brand over all eye fixations). The percentage of consumers noting the brand is the standard metric used by commercial eye-tracking studies to measure the attention effect of P-O-P marketing (Young 1996). Because the length of time between eye movements is relatively constant, gaze duration is a continuous indicator of the total number of fixations on the brand (Rayner 1998; Wedel and Pieters 2000). In the absence of studies distinguishing between the memory impact of noting and gaze duration, I expect that both should influence brand recall:

- H1:** a—Noting (making at least one eye fixation) increases the likelihood of brand recall.
b—Gaze duration increases the likelihood of brand recall.

Visual attention to brands other than the target brand can create interference and hence decrease the accessibility of the target brand in memory (Anderson and Neely 1996). The amount of interference is influenced by the order of attention. Except for the brand noted first and the brand noted last, brand recall is subject to both retroactive interference (caused by the attention to brands noted after the target brand) and to proactive interference (caused by the attention to brands noted before the target brand). The brand noted first is only subject to retroactive interference and should therefore be more memorable than brands noted after it (primacy effect). Similarly, the brand noted last is only subject to proactive interference and should be more memorable than

brands noted before it (recency effect). The amount of interference is also influenced by the time elapsed until the target brand is noted (Pieters and Bijmolt 1997). According to the attention decrement hypothesis, people pay more attention to stimuli noted at the beginning of the attention task than at the end (Anderson 1981; Steiner and Rain 1989). Brands noted at the beginning of a purchase decision task should be more memorable than brands noted later (decay effect).

There is strong support for primacy, recency, and timing effects on memory for brands in an advertising context. Wedel and Pieters (2000) found a strong recency effect and a weak primacy effect for brand name recognition as a function of the page number of the ad in a magazine. Pieters and Bijmolt (1997) found a primacy, a recency, and a decay effect for brand recall as a function of the position of the television advertisement in a commercial break. However, these results were obtained in studies in which the order and timing of attention to the ads were mostly exogenously determined, either by the television network or by the magazine publisher. At the point of purchase, consumers can endogenously direct attention to the brands they prefer, because these brands are more likely to be pre-attentively recognized (Drèze et al. 1994) and because they have a higher expected utility (Meyer 1982; Simonson, Huber, and Payne 1988). Supporting this argument, Russo and Leclerc's (1994) study of attention to brands in supermarket displays found that the brand that is ultimately chosen is fixated more often than its chance rate in the earlier stages of the decision process.

At the point of purchase, the serial order and timing of attention to brands are linked to both the amount of competitive interference, the amount of attention, brand preferences. These effects work together to make brands noted first and noted early more memorable (because of the lack of proactive interference, the higher attention at the beginning of the task, and the higher accessibility of preferred brands). For brands noted last, however, the negative memory effect of being a less-preferred brand and of being at the end of the attention task should overcome the positive memory

effect due to the lack of retroactive interference. Supporting this argument, Kent and Allen (1994) found that brand preferences are a stronger driver of memory for brands than the amount of competitive interference. I therefore expect that:

- H2:** a—The brand noted first is more likely to be recalled than the brands noted after it.
b—The brand noted last is less likely to be recalled than the brands noted before it.
c—The time elapsed until the first eye fixation decreases brand recall.

Category structure effects

Product category knowledge is typically organized by type or brand subcategories (Nedungadi, Chattopadhyay, and Muthukrishnan 2001). For example, Hutchinson, Raman and Mantrala (1994) showed that the soft drinks category is structured by type (e.g., cola, lemon-lime) and by umbrella brand (e.g., all Coca-Cola brands, all Sprite brands). Brands belonging to the same category are also called related brands, because they are linked to a common retrieval cue such as the same umbrella brand name (Chandler 1993). Hutchinson, Raman and Mantrala (1994) showed that brand recall is activated in clusters of related brands. Recalling a member of a subcategory activates the other members of the category, which are more likely to be recalled. For example, compared to recalling Sprite, recalling Coca-Cola Diet increases the likelihood of recalling Coca-Cola Classic and Coca-Cola Caffeine Free.

- H3:** Compared to recalling an unrelated brand, recalling a brand of an umbrella brand subcategory increases the likelihood of recalling the other brands of the subcategory.

Category structure not only influences the effect of *recall* on the recall of related brands, but also the effect of *noting* on the recall of related brands. Research has shown that priming a member of a subcategory (e.g., Coca-Cola Classic) inhibits the recall of other members of the subcategory (e.g., Coca-Cola Diet) more than the recall of members of other subcategories (e.g., Sprite). This effect is known as “the part-set cuing effect” (Alba and Chattopadhyay 1985, 1986). If, as stated in H1, noting a brand can serve as a brand prime because it increases its accessibility in memory, the

part-set cuing effect suggests that noting a brand should reduce the likelihood of recalling other brands sharing the same umbrella brand name.

Nedungadi (1990) qualified the part-set cuing effect by showing that it is moderated by the relative accessibility of the primed and related brand. Nedungadi distinguishes between major and minor subcategories and between major and minor brands in each subcategory depending on their accessibility in memory. He showed that priming a brand has both a direct effect (increasing the accessibility of the primed brand) an indirect priming effect (increasing the accessibility of the other brands of the subcategory), especially for minor subcategories. Indirect priming benefits the majors brand because they are more accessible in memory, and are thus more likely to be recalled once the whole subcategory has been made accessible through indirect priming. As stated by Nedungadi (1990, p. 266): “recall of the major brands in each subcategory will benefit more (indirectly) from the priming of the minor brands in their subcategories than the minor brands will benefit from the priming of their major brand counterparts”.

This reasoning has the following implications for the effect of noting on the recall of brands sharing the same umbrella brand. Assuming that the umbrella brand subcategories studied are not always accessible in memory (an empirical question), a part-set cuing effect is only expected when the brand primed is a major brand. For example, noting Sprite regular (a major brand) should decrease brand recall for Sprite diet (a minor brand). In contrast, priming a minor brand should facilitate the retrieval of the major brands of the subcategory. Noting Sprite Diet should increase the likelihood of recalling Sprite regular.

- H4:** a—Compared to noting an unrelated brand, noting a major brand of an umbrella brand subcategory reduces the likelihood of recalling a minor brand of the same subcategory.
b—Compared to noting an unrelated brand, noting a minor brand of an umbrella brand subcategory increases the likelihood of recalling a major brand of the same subcategory.

External retrieval cues effects

Measuring brand recall instructions use an external retrieval cue, which can either be the name of the category (in unaided recall tasks) or the name of some or all the brands in the category (in aided recall tasks). Aided and unaided brand recall scores are typically highly correlated and yet discriminable (Finn 1992). Because the debate about which recall measure is superior to gauge advertising effectiveness has not been settled, most commercial studies first collect unaided recall and then aided recall (Singh, Rothschild, and Churchill Jr. 1988; Young 1996).

Memory research suggests that using brand names as external retrieval cues should enhance the link between attention and memory, and thus make aided recall a more accurate measure of attention than unaided recall. Unaided recall requires both the retrieval of alternatives from memory and the discrimination between possible alternatives whereas aided recall only requires discrimination. When the level of information processing is very superficial, which is the case at the point of purchase, consumers fail to recall many brands that they had noted, which puts an upper bound on the accuracy of unaided recall (Mandler 1980). In addition, the brand names provided as external cues in aided recall tasks are some of the cues consumers used for encoding what they saw at the point of purchase. This, according to the encoding specificity theory, should increase the accuracy of aided recall compared to unaided recall (Tulving and Thomson 1973). These arguments are supported by a study by Pieters and Bijmolt (1997), which shows that unaided brand recall following exposure to television advertising is less accurate than aided brand recall because it is subject to more competitive interference and to stronger serial order and timing effects.

These arguments and results suggest that the link between visual attention and memory is stronger for aided recall than for unaided recall. Conversely, they suggest that category structure and brand familiarity, because they influence the accessibility of related brands in memory rather

than the ability to discriminate between these brands, have a stronger impact on unaided recall than on aided recall.

- H5:** a—Noting has a stronger impact on aided recall than on unaided recall (aided recall is a more accurate indicator of noting than unaided recall).
b—Brand familiarity and recalling or noting related brands have a stronger impact on unaided recall than on aided recall.

STUDY 1: ATTENTION AND CATEGORY STRUCTURE EFFECTS ON UNAIDED AND AIDED BRAND RECALL

The purpose of Study 1 is to test the effect, on brand recall, of the occurrence (H1a), duration (H1b), serial order (H2a and H2b), and timing (H2c) of visual attention to the target brand and the effect of recalling (H3) and noting major (H4a) and minor (H4b) related brands. Study 1 also serves to test whether visual attention to the target brand (H5a) and brand familiarity and category structure (H5b) influence aided and unaided recall differently.

Procedure and stimuli

The data were collected in collaboration with Perception Research Services, Inc. (PRS) of Fort Lee, NJ. Study 1 followed the procedure used by Nedungadi (2000) to measure brand recall, with the addition that the eye movements of consumers were being tracked while they were choosing a brand from a supermarket shelf. A total of 159 consumers were recruited in shopping centers in four US cities (Chicago, Los Angeles, Saint Louis, and San Diego) and offered \$10 for their participation. The consumers were female heads of household responsible for the majority of their grocery shopping. Their age ranged from 24 to 65, they had at least a high-school education and earned a minimum annual household income of \$25,000.

– Insert Figure 1 about here –

Each consumer was seated and told that she would see a series of ads like those found in magazines or a series of products like those found in stores. Consumers went through a calibration

procedure requiring them to look twice at a blank 35mm slide with five circles projected on a 4 x 5 feet screen located approximately 80 inches away from the seat. Their eye movements were tracked using infrared corneal reflection (ISCAN model #AA-UPG-421), which does not require headgear. Consumers then looked at four or five training displays and at six pictures of individual packages or print ads for an unrelated study. Prior to viewing the last stimuli (the one used in the study), subjects were told that they would see a the picture of supermarket shelf displaying fruit juices and were instructed to say which one they would consider buying, while their eyes were being tracked. After completing the eye-tracking task, consumers went to a separate room for the announced unaided and aided recall tests. Unaided recall was measured by asking the following question: “Thinking of the soft drinks you just saw, please tell me the names of the brands and products you remember seeing. Please try to be as specific as you can”. A research assistant recorded the names of the brands recalled. She then showed consumers a list of brand names arranged in alphabetical order and read the aided recall question: “Here is a list of different brand names of orange juices. Please tell me which of these, if any, you definitely remember having just seen, even if you mentioned them before”. All the brands of the list were present on the shelf (but not all had been noted by each consumer).

The stimulus used was a picture of supermarket shelves presenting 16 widely-available fruit juices, from now on referred as “brands”.¹ The brands were defined so as to match the classification used in the memory interviews. For example, there were 3 different brands with the Tropicana umbrella brand name (Tropicana Pure Premium, Tropicana Season’s Best, and Tropicana Pure Tropics). The price of each brand was a regular, non-promotional one at the time

¹ Four slightly different versions of the picture shown in Figure 1 were tested, each in a different city. Depending on the picture, up to four shelf-talkers displaying the brand’s logo were added to Jaffa, Tropicana, Minute Maid from Concentrate, Dole, and Pathmark. Because the presence of these shelf talkers was confounded with the test location, no hypotheses were made regarding their impact on visual attention or brand recall, and the data were aggregated across the four test locations.

of the study. In order to test memory for brands never seen before, a fictitious brand, “Jaffa,” was inserted in the shelf layout. The packaging of Jaffa was patterned after products sold outside the United States and its price was determined during pre-tests to position it as a regional or store brand. Among the 16 brands of fruit juices, 7 had a single umbrella brand (e.g., Donald Duck) and 9 shared an umbrella brand name with at least one other brand. Following the procedure used by Nedungadi (1990) these nine brands were classified as either major or minor based on their US market share and on the typicality of their brand names (including “pure premium” vs. other denominations). Major and minor brands were, respectively, Tropicana Pure Premium vs. Tropicana Pure Tropics and Tropicana Season’s Best, Florida Gold Premium vs. Florida Gold Valencia, Pathmark Premium vs. Pathmark from Concentrate, Minute Maid Premium vs. Minute Maid from Concentrate.

Empirical analysis

Hypotheses H1 through H5 are tested using a generalized ordered logit model, which allows the effects of the independent variables to be tested on unaided and aided recall simultaneously. The generalized ordered logit model exploits the ordinal structure of the recall data. Because all the brands recalled in the unaided task were also recalled in the aided task, the dependent variable, *RECALL*, has three levels. They are, in order of difficulty, (0) if the brand was not recalled at all, (1) if it was recalled in the aided task but not in the unaided task and (2) if it was recalled in the unaided task (and hence also in the aided task). Unlike the more common ordered logit or probit models, the generalized ordered logit model relaxes the parallel regression assumption, which assumes that explanatory variables have the same effect on the odds that the dependent variable is above any dividing point (Clogg and Shihadeh 1994). The generalized ordered logit model therefore estimates a vector of independent variable parameters and a constant for both aided recall and unaided recall.

Because the generalized ordered logit (GOLOGIT) model has never been used in the marketing literature to date, I briefly explain its structure. The GOLOGIT model estimates a set of coefficients \mathbf{B}^k corresponding to a set of cumulative distribution functions F :

$$(1) \quad P(\text{RECALL} < k) = F(-\mathbf{XB}^k) \quad \text{where } k = 1 \text{ or } 2.$$

From this set of cumulative distribution functions, the probabilities that *RECALL* will take on each of the values 0, 1, 2 can be derived as follows (Fu 1998):

$$(2.1) \quad P(\text{RECALL} = 0) = F(-\mathbf{XB}^1)$$

$$(2.2) \quad P(\text{RECALL} = 1) = F(-\mathbf{XB}^2) - F(-\mathbf{XB}^1)$$

$$(2.3) \quad P(\text{RECALL} = 2) = 1 - F(-\mathbf{XB}^2)$$

The generalized ordered logit model uses the logistic distribution as the cumulative distribution, which allows this model to be interpreted in terms of logits:

$$(3) \quad \ln\left(\frac{P(\text{RECALL} \geq k)}{P(\text{RECALL} < k)}\right) = \mathbf{XB}^k \quad \text{where } k = 1 \text{ or } 2.$$

The parallel regression assumption of ordered logit models restrict the \mathbf{B}^k coefficients to be the same for every k . In a GOLOGIT model, \mathbf{B}^1 and \mathbf{B}^2 can be estimated for the following two logits:

$$(4.1) \quad \ln\left(\frac{P(\text{RECALL} \geq 1)}{P(\text{RECALL} = 0)}\right) = \mathbf{XB}^1$$

$$(4.2) \quad \ln\left(\frac{P(\text{RECALL} = 2)}{P(\text{RECALL} < 2)}\right) = \mathbf{XB}^2$$

The parameters \mathbf{B}^1 and \mathbf{B}^2 correspond to the two possible cumulative binary logits that can be formed from the three-category *RECALL* dependent variable, using the first level (*RECALL* = 0) as the base level. As shown in (4.1), \mathbf{B}^1 is the vector of variable coefficients corresponding to the first logit, aided recall, formed from the two following categories: No aided recall (*RECALL* =

0) vs. aided recall ($RECALL = 1$ or 2). As shown in (4.2), \mathbf{B}^2 is the vector of variable coefficients corresponding to the second logit, unaided recall, formed from the two following categories: No unaided recall ($RECALL = 0$ or 1) vs. unaided recall ($RECALL = 2$).

The first empirical analysis tests all hypothesized effects (except for serial order and timing effects, which can only be tested for brands noted) with the following matrix of independent variables and parameters (see Table 1 for definitions and coding):

$$(5) \mathbf{XB}^k = \beta_0^k + \beta_1^k NOTING + \beta_2^k GAZE + \beta_3^k NOTREL_{major} + \beta_4^k NOTREL_{minor} \\ + \beta_5^k RECREL_{major} + \beta_6^k RECREL_{minor} + \beta_7^k BRDFAM_{medium} + \beta_8^k BRDFAM_{high} \\ + \sum_{i=9}^{11} \beta_i^k CITY_i + \sum_{j=12}^{26} \beta_j^k BRAND_j + \sum_{m=27}^{72} \beta_m^k CITY_i * BRAND_j$$

where $k = 1, 2$, identifies the two logits, aided recall (1) and unaided recall (2); β_l^k , $l = 0, 1, \dots, 72$ are the response parameters for each equation k . *NOTING* is a binary variable, which indicates whether at least one eye fixation is made on the brand. *GAZE* is a continuous variable, which measures the total time spent fixating the brand over all eye fixations. *NOTREL_{major}* and *NOTREL_{minor}* are two binary variables capturing, respectively, the effects of noting a major and a minor related brand. Similarly, *RECREL_{major}* and *RECREL_{minor}* are two binary variables capturing, respectively, the effects of recalling a major and a minor related brand. *BRDFAM_{medium}* and *BRDFAM_{high}* are two binary variables capturing, respectively, the effects of medium and high brand familiarity. Finally, *CITY_i* where $i = 7, 8, 9$ are three city-specific intercepts identifying where the data were collected, *BRAND_j* where $j = 12, 13, \dots, 26$ are 15 brand-specific intercepts and *CITY_i*BRAND_j* capturing the effects of the 45 city-brand combinations.

– Insert Table 1 about here –

To test the effects of the serial order and timing of attention among brands noted (H2), a second analysis is conducted on a restricted sample consisting only of brands noted and of

consumers who noted at least 8 brands. Gaze duration, past usage and the city-specific and brand-specific variables are kept in the equation as covariates. The matrix of independent variables and their parameters is as follows:

$$(6) \mathbf{XB}^k = \beta_0^k + \beta_1^k \text{FIRST} + \beta_2^k \text{LAST} + \beta_3^k \text{NOTTIME} + \beta_4^k \text{GAZE} + \beta_5^k \text{BRDFAM}_{\text{medium}} \\ + \beta_6^k \text{BRDFAM}_{\text{high}} + \sum_{i=7}^9 \beta_i^k \text{CITY}_i + \sum_{j=10}^{24} \beta_j^k \text{BRAND}_j + \sum_{m=25}^{69} \beta_m^k \text{CITY}_i * \text{BRAND}_j$$

where $k = 1, 2$, identifies the dividing point, aided recall and unaided recall; β_l^k , $l = 0, 1, \dots, 69$ are the response parameters for each equation k . *FIRST* and *LAST* are two binary variables which indicate, respectively, whether the brand was the first brand noted or the last brand noted by the consumer. *NOTTIME* is a continuous variable, which measures the time elapsed between the beginning of the eye-tracking task and the first eye fixation on the brand.

Because multiple observations originate from the same consumer, the two generalized ordered logit models were estimated via maximum likelihood using the robust Huber-White estimates of variance (Hosmer and Lemeshow 2000). This procedure has two main advantages over random-effect models. First, it does not require specifying, a priori, the error variance structure. Second, the variance estimates are robust to multiple types of within-consumer correlation and, therefore, provide correct coverage rates to more than panel-level heteroskedasticity.

Descriptive results

Table 2 shows the relative frequencies of noting, on the one hand, and aided and unaided recall on the other. Table 2 also provides three measures of the association between these variables. The discrimination index corrects for guessing (answering the recall question positively when uncertain). Using the threshold model of signal detection theory (Snodgrass and Corwin 1988), the discrimination index (Pr) is the hit rate (proportion of brands noted that are accurately

recalled) minus the false alarm rate (proportion of brands not noted that are inaccurately recalled). The bias index shows the proportion of recall errors due to false alarms as opposed to misses (not recalling a brand noted). In the threshold model, the bias index (Br) is the proportion of false alarms among all recall errors (false alarms and misses).

-- Insert Table 2 about here --

As Table 2 shows, the aggregate association between noting and unaided recall is weak but statistically significant. Consumers noted 10.5 brands out of the 16 brands shown in the picture, but recalled only 4.5 brands in the unaided recall task. In addition, out of the 4.5 brands recalled unaided, only 3 were actually noted. Consumers inaccurately recalled 1.5 brands that they did not note during the eye tracking task. As a result, the probability of unaided recall is only marginally superior for a brand noted than for a brand not noted (29% vs. 25%). Finally, the bias index shows that most unaided recall errors are misses (failures to recall a brand noted). Unaided recall is conservative ($Br = .26$): when uncertain, consumers are likely to fail to recall the brand in the unaided recall task. Providing consumers with the names of the brands originally available in the store increases the number of brands recalled from 4.5 to 8.2. Out of these 8.2 brands, 5.6 were really fixated and 2.6 were inaccurately recalled (aided). The probability of aided recall is, again, only marginally superior for a brand noted than for a brand not noted (53% vs. 47%). In contrast to unaided recall, however, aided recall is unbiased ($Br = .50$): When uncertain, consumers are as likely to recall a brand as not to recall it in the aided recall task.

Generalized ordered logit results

To examine whether the added complexity of the generalized model is warranted, a simple ordered logit model was also estimated via maximum likelihood and robust Huber-White variance estimates on the full sample of 1,915 observations (after listwise deletion of missing values). Fit indices show that the ordered logit model with 73 parameters ($LL = -1556$, McFadden's $R^2 = .25$,

AIC = 1.67, BIC = -11150) does not fit the data as well as the generalized ordered logit model with 144 parameters (LL = - 1479, McFadden's $R^2 = .29$, AIC = 1.66, BIC = -10766). A likelihood ratio test comparing the two models shows that the improvement in fit is strongly significant ($\chi^2_{(71)} = 19458$, $p < 0.00001$), and that, therefore, the parallel regression assumption of the ordered logit model is violated.

Table 3 reports the parameter estimates of equation (5), the general analysis testing hypotheses H1 and H3 through H6 on the complete sample. Table 3 provides the parameter estimates and the chi-squared value of an univariate Wald test for aided recall (i.e., testing whether $\beta_j^1 = 0$) and for unaided recall (i.e., testing whether $\beta_j^2 = 0$). Table 3 also reports the chi-squared value of a multivariate Wald test, which tests whether the parameters for aided and unaided recall are simultaneously zero (i.e., testing whether $\beta_j^1 = \beta_j^2 = 0$). The last column in Table 3 reports the chi-squared value of a Wald test of the equality of the coefficients for aided and unaided recall (i.e., testing whether $\beta_j^1 = \beta_j^2$). Finally, Table 3 reports three pooled tests. The first one tests the overall effect of noting a major and minor related brand compared to noting an unrelated brand. The second one tests the overall effect of recalling a major and minor related brand compared to recalling an unrelated brand, and the third one tests the overall effect of high and medium brand familiarity compared to low brand familiarity. To improve the clarity of Table 3, the parameters of the constant and of the city-specific and brand-specific variables are not reported.

-- Insert Table 3 about here --

H1a states that noting a brand increases the chances that it will be recalled and H1b makes a similar hypothesis for gaze duration. As the joint multivariate Wald test shows, both hypotheses are supported ($\chi^2_{(2)} = 8.28$, $p < 0.02$ for noting the brand and $\chi^2_{(2)} = 6.49$, $p < 0.04$ for gaze

duration), showing that visual attention does increase the accessibility of the brand in memory. Looking at aided and unaided recall separately, however, shows that the two components of visual attention work at different levels of memory: Noting a brand is sufficient to improve aided recall, but multiple eye fixations are necessary to impact unaided recall. More formally, the coefficient of *NOTING* is statistically significant for aided recall ($\chi^2_{(1)} = 7.81, p < 0.01$) but not for unaided recall ($\chi^2_{(1)} = 1.45, p = 0.23$). Conversely, the coefficient of *GAZE* is not statistically significant for aided recall ($\chi^2_{(1)} = 2.86, p = .09$) but is significant for unaided recall ($\chi^2_{(1)} = 5.83, p < 0.02$). Overall, these results show that, as hypothesized in H5a, aided recall is a better indicator than unaided recall of whether or not the brand was noted (the hypothesis of equal parameters is rejected: $\chi^2_{(1)} = 3.76, p < 0.05$).

Attention to the target brand is not the only predictor of brand recall. In fact, brand familiarity has a very strong impact on both aided and unaided recall. Contrary to H5b, however, brand familiarity influences unaided recall and aided recall similarly. As expected, category structure also influence brand recall. As hypothesized in H3, recalling related brand increases the likelihood of recalling the target brand ($\chi^2_{(4)} = 20.06, p < 0.01$ for the multivariate test of *RECREL_{major}* and *RECREL_{minor}*) and it does not matter whether the brand recalled is a major or a minor brand. Finally, as hypothesized in H5b, recalling a related brand has a stronger impact on unaided recall than on aided recall ($\chi^2_{(4)} = 8.43, p < 0.01$).

As expected in H4, category structure also influences brand recall when a related brand is noted (and not necessarily recalled). The joint test of the pooled effects of *NOTREL_{major}* and *NOTREL_{minor}* on aided and unaided recall is statistically significant ($\chi^2_{(4)} = 10.18, p < 0.04$), showing that the parameters of these two variables on aided and unaided recall are not simultaneously zero. Second, as predicted in H5b, noting a related brand has a stronger impact on unaided recall than on aided recall (the hypothesis of equal parameters is rejected: $\chi^2_{(2)} = 8.23, p <$

0.02). In fact, noting a related brand has no impact on aided recall ($\chi^2_{(2)} = 0.05$, $p = 0.97$), showing that it influences the ability of retrieve related brands but not the ability to discriminate between them. Examining unaided recall separately provides support for H4a. Noting a major brand, say Florida Gold Pure Premium, decreases the unaided recall of the other brand with the Florida Gold umbrella brand, Florida Gold Valencia ($\beta_3^2 = -0.63$, $\chi^2_{(1)} = 5.61$, $p < 0.02$). In contrast, noting a minor brand, say Florida Gold Valencia, increases the unaided recall of Florida Gold Pure Premium ($\beta_4^2 = 0.85$, $\chi^2_{(1)} = 3.61$, $p = 0.05$). In sum, noting a related brand interferes with the recall of the target brand, but its impact is asymmetric: noting a major brand inhibits whereas noting a minor brand enhances the recall of the other brands of the umbrella brand subcategory.

-- Insert Table 4 about here --

A second empirical analysis was used to estimate equation (6) and test hypothesis H3 about serial order and timing of attention effects. This analysis was conducted on a restricted sample consisting only of brands noted and of consumers noting at least 8 brands (1215 observations). Table 4 shows the variable parameters, using the same format as Table 3. As expected in H2, serial order influences aided recall ($\chi^2_{(2)} = 6.04$, $p < 0.05$ for the pooled test). Consistent with the expected primacy effect, aided recall is higher for the brand noted first than for the brand noted after, but the effect is not statistically significant ($\chi^2_{(1)} = 1.74$, $p = 0.18$) and H2a is thus not supported. Consistent with the expected reverse recency effect, aided recall is lower for the brands noted last than for the brands noted before ($\chi^2_{(1)} = 4.54$, $p < 0.04$), and H2b is supported. Finally, the time elapsed between the start of the eye-tracking experiment and the first eye fixation on the brand has no impact on aided or unaided recall ($\chi^2_{(2)} = 1.93$, $p = 0.38$), and thus H3c is not supported.

Discussion

A key empirical result of these analysis is that, although consumers were instructed to recall what brands they had just looked at just minutes before, their recall was predominantly driven by brand familiarity and little by whether or not they had actually noted the brand in the display. The odds of unaided brand recall are 7.3 times larger for a familiar brand than for a brand never purchased in the past. In comparison, the odds of unaided recall are only 1.2 times larger if the brand was noted compared to if it was never looked at. Although aided recall is a better indicator of noting than aided recall, the difference in magnitude between familiarity and attention effects remains as impressive (see Table 1).

That noting and recalling a brand are only weakly linked, however, does not directly answer the second question raised in this research about whether marketers could make inferences about visual attention from memory data. One way to address this issue is to compare the effects of the same factors on the likelihood of noting the brand and on the likelihood of recalling it. This would not provide a definitive answer to the question of whether memory can be used as a proxy for attention in all the contexts in which it has been used. However, showing that large differences in visual attention across stimuli, consumers, and brands cannot be recovered from recall scores would caution researchers against making similar inferences for more subtle effects. This analysis is the focus of Study 2.

STUDY 2: INFERRING VISUAL ATTENTION TO BRANDS AT THE POINT OF PURCHASE FROM RECALL DATA

Because measuring consumer attention with process-tracing methods such as eye movement recording is costly and requires long calibration procedures, researchers have used memory data as a proxy for attention to a variety of objects and in a variety of tasks. In three studies, Roskos-Ewoldsen and Fazio (1992) measured the impact of attitude accessibility on attention by asking

consumers to recall the objects presented in a display. The same procedure is commonly used in research on the attention-getting effectiveness of product warnings (Barlow and Wogalter 1993; Frantz and Rhoades 1993; Lehto and Miller 1988; Malouff et al. 1993) and consumer evaluation of point-of-purchase displays. For example, Broniarczyk, Hoyer, and McAlister (1998) measured perceived assortment variety using, in part, consumer memory of the presence or absence of brands in different assortments. Using recall data as a proxy for attention to brands at the point of purchase would be particularly useful given the difficulties of observing in-store visual attention behavior reliably and unobtrusively (but see Cole and Balasubramanian 1993; Hoyer 1984).

Data and method

Data on visual attention and recall were collected following the same procedure as in Study 1 but for a different category: liquid laundry detergent. The stimuli used in this study were pictures of 10 brands of liquid laundry detergents displayed on a supermarket shelf. As Figure 2 shows, these shelf layouts were simpler than those used in Study 1, enhancing the chances of agreement between visual attention and memory. Depending on the test location (Boston, Fort Lauderdale, Houston, and Philadelphia), the picture included up to four shelf talkers on some brands (Clin, Tide, Surf, Wisk, and Cheer). Because the inclusion of shelf talkers was confounded with the test location, no hypotheses are made regarding their effect on attention or memory. Differences in stimuli across test locations are a means to create between-subject variance in attention and to estimate how well this variance is picked up by memory data. As for the juices stimuli, a fictitious brand, Clin, was inserted in the shelf layout. Its packaging was patterned after products sold outside the United States and its price was determined during pre-tests to position it as regional or store brand. A total of 150 adult consumers were recruited for Study 2. Their demographic profile was similar to the profile of the consumers who were recruited for Study 1.

– Insert Figure 2 about here –

Study 2 examines whether between-subjects differences across test location and stimuli (*CITY*), within-subjects differences in brand familiarity (*BRDFAM*), and residual brand-specific effects (*BRAND*) have the same impact on noting (*NOTING*) as on unaided brand recall (*UARECALL*). *NOTING* was chosen among the visual attention variables because it measures the construct of interest in the studies making inferences about visual attention from memory data. *UARECALL* and the independent variables were chosen because they are more commonly used in studies inferring attention from memory data. For example, the *CITY* variable, which captures changes in shelf layout across test locations, is analogous to the assortment manipulation in Broniarczyk, Hoyer, and McAlister (1998).

Because it is not possible to compare the variable parameters of independent binary logistic regressions, a log-linear model was used to estimate the association between multiple categorical variables (DeSarbo and Hildebrand 1980). More formally, I fitted the logarithm of the expected probability p_{ijkl} in cell (i, j, k, l, m) of an $I \times J \times K \times L \times M$ contingency table formed by the variables *NOTING*, *UARECALL*, *CITY*, *BRDFAM*, and *BRAND*. p_{ijkl} is the proportion of observations where *NOTING* = i , *UARECALL* = j , *CITY* = k , *BRDFAM* = l , and *BRAND* = m . I first fitted a model with all the appropriate two-way and three-way interactions, which can be expressed with the notation of Fienberg (1994) as follows:

$$(7) \quad \ln(p_{ijkl}) = u + u_i^{NOTING} + u_j^{UARECALL} + u_k^{CITY} + u_l^{BRDFAM} + u_m^{BRAND} + u_{ij}^{NOTING \times UARECALL} \\ + u_{ik}^{NOTING \times CITY} + u_{il}^{NOTING \times BRDFAM} + u_{im}^{NOTING \times BRAND} \\ + u_{jk}^{UARECALL \times CITY} + u_{jl}^{UARECALL \times BRDFAM} + u_{jm}^{UARECALL \times BRAND} \\ + u_{ijk}^{NOTED \times UARECALL \times CITY} + u_{ijl}^{NOTED \times UARECALL \times BRDFAM} + u_{ijm}^{NOTED \times UARECALL \times BRAND}$$

where $i = 0, 1; j = 0, 1; k = 1, 2, 3, 4; l = 1, 2, 3; m = 1, 2, \dots, 10$; *NOTING* indicates whether the brand was noted (1) or not (0); *UARECALL* indicates whether the brand was recalled unaided (1) or not (0); *CITY* indicates whether the picture is the one tested in Boston (1), Fort Lauderdale

(2), Houston (3), or Philadelphia (4); *BRDFAM* is measured as in the previous study; and *BRAND* has 10 levels, each identifying one detergent brand. I then compared the fit of log-linear model shown in (7) with a restricted model with no three-way interaction, shown in (8), which assumes that *CITY*, *BRDFAM*, and *BRAND* have the same impact on *NOTING* as on *UARECALL*:

$$(8) \quad \ln(p_{ijkl}) = u + u_i^{NOTING} + u_j^{UARECALL} + u_k^{CITY} + u_l^{BRDFAM} + u_m^{BRAND} + u_{ij}^{NOTING \times UARECALL} \\ + u_{ik}^{NOTING \times CITY} + u_{il}^{NOTING \times BRDFAM} + u_{im}^{NOTING \times BRAND} \\ + u_{jk}^{UARECALL \times CITY} + u_{jl}^{UARECALL \times BRDFAM} + u_{jm}^{UARECALL \times BRAND}$$

Results and discussion

Figure 3 shows the observed probabilities of noting and unaided recall for the 10 detergent brands. As expected, because of the higher simplicity of the detergent layout, the two variables are more strongly associated than for juices ($\chi^2_{(1)} = 18.5$, $p < 0.01$). The odds of unaided recall are 70% higher if the brand was noted compared to if it was not (compared to 20% in Study 1). Yet, as Figure 3 shows, aggregate recall scores cannot be used to rank brands in order of visibility (Spearman's rank order correlation = .40). For example, Purex, the brand most likely to be noted (noting = .91), is only the sixth brand most likely to be recalled (unaided recall = .39). Similarly, Surf, the brand least likely to be noted (noting = .38), is the fifth most recalled brand (unaided recall = .41).

To formally test whether differences in attention across test location, familiarity, and brands can be inferred from memory data, log-linear models (7) and (8) were fitted on the detergent data (1,367 observations). A likelihood ratio test shows that the improvement in fit between models (8) and (7) is statistically significant ($\chi^2_{(15)} = 29.1$, $p < 0.02$), demonstrating that the *CITY*, *BRDFAM*, and *BRAND* variables have a different impact on noting than on unaided recall.

To better understand the source of the discrepancy, Table 5 shows parameter estimates of two binary logistic regressions of, respectively, *NOTING* and *UARECALL*, on *CITY*, *BRDFAM*,

and *BRAND* (dichotomized via dummy coding). All three sets of variables influence noting and visual attention differently. First, differences in average noting probabilities across test locations are not uniformly reflected in recall scores. For example, the odds of noting any brand in the second test location are less than half the odds of noting any brand in the first test location, the default level ($\chi^2_{(1)} = 20.17$, $p < 0.01$, $e^B = .45$). Yet, there are no differences in average brand recall probabilities between the two test locations ($\chi^2_{(1)} = 0.02$, $p = 0.89$, $e^B = 1.03$). Second, brand familiarity has a larger impact on recall than on noting ($\chi^2_{(2)} = 6.24$, $p < 0.05$ for noting vs. $\chi^2_{(2)} = 75.5$, $p < 0.001$ for recall). For example, a high brand familiarity increases the odds of recall by 408% but increases the odds of noting by only 13%. Finally, recall data cannot be used to estimate the ranking of brands with respect to their attention-getting power even once the effects of test location and brand familiarity have been covaried out. For example, Ajax is noted more but recalled less than Wisk (the brand used as the default level) and both differences are strongly significant ($\chi^2_{(1)} = 15.85$, $p < 0.01$ for noting vs. $\chi^2_{(1)} = 9.0$, $p < 0.01$ for recall).

Overall, these results show that memory scores do not capture differences in visual attention across stimuli, consumers, and brands. Specifically, the effects of test location, brand familiarity, and brand residuals on the likelihood of noting the brand cannot be inferred from their impact on the likelihood of recalling the brand. These results provide a strong caution against using memory data to infer consumer visual attention to brands, given the relative simplicity of the stimuli (only 10 brands) and the relative strength of the differences in visual attention (the average percent absolute deviation in noting probabilities across stimuli, familiarity levels, and brands was 196%).

GENERAL DISCUSSION

Summary of main findings

This research examines the link between visual attention and memory for brands at the point of purchase. This is of interest to marketers, who rely on brand recall scores to measure the

effectiveness of their point-of-purchase advertising, and to researchers, who often use memory data to study consumer attention. To achieve this goal, two studies tracked the eye movements of consumers while they were choosing a brand from a supermarket shelf display, and collected aided and unaided brand recall data shortly thereafter.

Study 1 shows that brand recall is overwhelmingly driven by brand familiarity and only to a limited extent by whether the brand was actually looked at or not. In fact, there are no differences in unaided recall between brands noted and brands never looked at. This occurs although brand recall is measured shortly after brands are looked at and although consumers are specifically instructed to recall what brands they have just looked at (as opposed to what brands were available in the display). This study also shows that category structure influences brand recall. First, results show evidence of cluster-based retrieval (brands with the same umbrella brand name are recalled together). Second, this study provides the first empirical evidence that a single eye fixation can create indirect priming effects, inhibiting or enhancing the recall of related brands depending on the relative accessibility of the primed and target brands. Noting a major brand inhibits the recall of minor related brands whereas noting a minor brand enhances the recall of major related brands. Study 1 also shows that aided recall is a more accurate measure of noting than unaided recall because unaided recall is subject to more interference from category structure and familiarity. Finally, Study 1 fails to find primacy or attention decrement effects but finds a reverse recency effect, whereby the brand seen last is less likely to be recalled than the brands seen before.

That noting and recalling a brand are only weakly linked, however, does not directly answer the second question raised in this research about whether marketers could make inferences about visual attention from memory data. To achieve this goal, a second study was conducted to compare the effect of different stimuli, familiarity levels, and brands on the likelihood of noting the brand and on the likelihood of recalling the brand. Study 2 followed the same procedure as

Study 1 but for a simpler visual display of 10 detergents brands, so as to maximize the chances of agreement between attention and memory. Results are unequivocal. The large differences in noting probabilities across stimuli, consumers, and brands cannot be recovered from recall data. In fact, many comparisons of brands or stimuli show reversals between noting and recall scores. The dissociation between memory and attention is so large that aggregate recall scores cannot even be used to rank the brands in order of attention-getting power.

Consumer brand knowledge at the point of purchase

Across the two categories studied, the number of brands recalled significantly underestimated the number of brands actually noted, especially in the unaided task. Consumers noted 10.5 brands of juices but recalled only 8 brands (aided) and 4.5 brands (unaided). Similarly, consumers noted and recalled 7 brands of detergents (aided) but only 4 brands in the unaided task. Krugman's (1977) arguments that "conclusions about amount of exposure [to media advertising] based on recall data will greatly underestimate exposure [and that] conclusions about amount of exposure based on recognition data will somewhat underestimate exposure" are thus replicated for point-of-purchase advertising. Aided recall is more accurate because brands are more likely to be missed (noted but not recalled) in the unaided recall task than in the aided recall task (see Table 2). More generally, by showing that the parallel regression assumption was strongly violated, Study 1 demonstrated that aided and unaided brand recall are not simply two indicators of the strength of a memory trace. These results suggest the existence of different processes underlying unaided and aided recall for brand at the point of purchase. Obviously, these results need to be further examined to assess their generalizability beyond the categories used in the study.

Memory for brand at the point of purchase is not only limited. As shown in Table 2, it is also biased towards misses (failures to recall a brand noted) rather than false alarms (false memories of seeing a brand never noted). False alarms are caused by consumers liberally guessing that the

brand was noted when they are uncertain. In the aided recall task, consumers can imagine that all the brands on the list were brands that were displayed in the picture. Many also know that they should be liberal in the aided test because they know that they missed many brands in the earlier unaided test (i.e., they know that there were more brands in the picture than the 4 or 5 that they were able to recall without help).

Understanding the occurrences of false alarms in the unaided task is more difficult. How can consumers remember seeing a brand that they have never looked at? To explore this issue, I estimated a binary logistic regression of unaided recall among brands not noted. This analysis shows that recall (and therefore a false alarm) is more likely when consumers are familiar with the brand and when they have recalled a major or minor related brand (the effects of noting related brands are weak). These results suggest that false alarms are due to brand familiarity and category structure effects in recall. However, the occurrence of false alarms for the fictitious brand Jaffa (FA=0.06), which no consumer had seen before and which is related to no other brands, indicates that at least some of them are due to peripheral vision. This contradicts previous studies, which found no memory of peripherally viewed pictures (Loftus 1972). One tentative explanation for this discrepancy is that the stimuli used by Loftus were located farther apart than in this study, and were hence more peripherally viewed.

Studying visual attention to brands at the point of purchase

This study shows that marketers who want to know whether a brand in a supermarket display is noted or not should use eye-tracking data, as this cannot be inferred from recall data. On the other hand, results show that recall is strongly associated with the number of eye fixations on the brand, a measure of the amount of visual information processing. Brand recall could therefore be used as an indirect measure of brand consideration. Of course, more research is necessary to examine the validity of using recall for this purpose outside the context of this study. Given the

overall disappointing accuracy of explicit recall tests, further research could examine whether implicit measures would be better indicators of visual attention to brands at the point of purchase. Monroe and Lee (1999) have argued that point-of-purchase knowledge is not always consciously accessible and should hence be measured using implicit memory tests. To support their argument, they have reviewed studies showing that implicit memory is sensitive to exposure effects even when explicit recollection is impaired by low involvement, divided attention, or shallow processing. Researchers could also distinguish between recall based on the conscious recollection of having looked at the brand and recall based on simple feelings of familiarity (Tulving 1989).

From a methodological perspective, this study shows the value of jointly modeling unaided and aided brand recall and of distinguishing between the occurrence of visual attention (noting) and the amount of visual information processing (gaze duration). Modeling brand recall and visual attention in this way shows that the first eye fixation is sufficient for brand-cued recall but that multiple eye fixations are required for category-cued recall. Further research is necessary to examine the role of the first and following eye fixations on variables of interest to marketers, such as sales. This would help marketers determine whether they should continue to measure the effectiveness of their point-of-purchase advertising using brand recall tests, or whether they should collect data at more intermediate levels in the hierarchy of effects, such as noting (to measure attention-getting power) or gaze duration (to measure in-store information processing).

Implications for memory research

This research shows that some well-documented findings from research on memory and attention in memory-based tasks and in advertising or choice contexts are replicated in the context of the point of purchase. In particular, this research provides the first empirical evidence that making one eye fixation to a brand displayed on a supermarket shelf is enough to create direct and indirect priming effects. This research also shows the robustness of cluster-based retrieval along

umbrella brands subcategories. Finally, it replicates the well-documented predominance of brand familiarity, compared to the effect of visual attention and of category structure.

On the other hand, the well-documented primacy, recency, and decay effects were not replicated. As previously discussed, this may be due to the endogeneity of attention at the point of purchase. Peripheral vision and consumer expectations of the location of the brand on the shelf can direct attention to preferred brands (Rayner 1998; Russo and Leclerc 1994). As a result, the amount of proactive and retroactive interference and the decrement in attention caused by the serial order and timing of attention may be confounded with brand preferences. The reverse recency effect found in this research (whereby the last brand noted is less likely to be recalled than the brands noted before) is consistent with a preference-ordered attention. More data like these would be useful for the debate on the importance of automaticity in visual attention (Rayner 1998).

Another well-documented finding of memory research is the “mirror effect” (Glanzer and Adams 1985, 1990), which states that factors increasing hit rates (in this study, the proportion of brands noted that are recalled) also increase correct rejection rates (in this study, the proportion of brands not noted that are not recalled). A well-known example of the mirror effect is that, compared to high-frequency words, low-frequency words are both more accurately categorized as “previously encountered” when they were previously encountered (higher hit rate) and as “never encountered” when they were never encountered (higher correct rejection rate). Comparing the antecedents of recall for brands noted and for brands not noted, however, provides no support for the mirror effect. Brand familiarity and the recall of a related brand increase brand recall when the brand is noted (higher hit rate) but also when the brand is not noted (*lower* correct rejection rate), a reverse mirror effect. The same pattern is observed for noting related brands, except that the effects are weaker. Another demonstration of the reverse mirror effect is the strong negative correlation between hit rate and correct rejection rate across juice brands ($r = -.87$ for unaided

recall and $r = -.89$ for aided recall): Brands that are correctly recalled when noted are, in fact, less likely to be correctly rejected when not noted.

One explanation for the absence of the mirror effect is that this effect requires that consumers make comparisons between the strength of the target brand and the expected strength of both noted and non-noted brands (Glanzer and Adams 1990). The results of this study, in contrast, are consistent with a simple strength model of memory. In such a model, consumers discriminate between brands on the basis of their accessibility in memory, which, as was shown, is strongly influenced by brand familiarity and category structure and little by attention priming. This raises the question of why the strength model is more appropriate for memory for brands at the point of purchase than for memory for objects. One reason may be that attention to brands at the point of purchase is goal-oriented and occurs under high time pressure, two factors that influence the amount and pattern of visual information acquisition (Janiszewski 1998; Pieters and Warlop 1999). Another reason is that brand packages and P-O-P advertising contain less information, are less original, and are more familiar than the objects used in other memory studies, which weakens the link between visual attention and memory (Pieters et al. 2001). These explanations offer avenues for research comparing the link between attention and memory at and outside the point of purchase.

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TABLE 1
DESCRIPTIVE STATISTICS AND VARIABLE CODING

Variable	Mean	SD	Min	Max	Description and coding
<i>NOTING</i>	.66	.47	0	1	Noting, a dummy-coded variable indicating whether at least one eye fixation is made on the brand (1) or not (0).
<i>GAZE</i>	.00	1.15	-1.02	22.23	Gaze duration, a continuous variable indicating the time spent fixating the brand across all eye fixations (in seconds). ^a
<i>NOTREL_{major}</i>	.19	.39	0	1	Noting a major related brand, a dummy-coded variable indicating whether a major brand of the umbrella brand subcategory is noted (1) or not (0). ^b
<i>NOTREL_{minor}</i>	.19	.39	0	1	Noting a minor related brand, a dummy-coded variable indicating whether a minor brand of the umbrella brand subcategory is noted (1) or not (0). ^b
<i>RECREL_{major}</i>	.13	.33	0	1	Recalling a major related brand, a dummy-coded variable indicating whether a major brand of the umbrella brand subcategory is recalled unaided (1) or not (0). ^c
<i>RECREL_{minor}</i>	.06	.23	0	1	Recalling a minor related brand, a dummy-coded variable indicating whether a minor brand of the umbrella brand subcategory is recalled unaided (1) or not (0). ^c
<i>BRDFAM_{medium}</i>	.52	.50	0	1	Medium brand familiarity, a dummy-coded variable indicating whether the brand has been considered for purchase in the past (1) or not (0). ^d
<i>BRDFAM_{high}</i>	.23	.42	0	1	High brand familiarity, a dummy-coded variable indicating whether the brand has been regularly purchased in the past (1) or not (0). ^d
<i>FIRST</i>	.09	.29	0	1	Primacy effect, a dummy-coded variable indicating whether the brand is the first brand noted (1) or not (0). ^e
<i>LAST</i>	.09	.29	0	1	Recency effect, a dummy-coded variable indicating whether the brand is the last brand noted (1) or not (0). ^e
<i>NOTTIME</i>	7.52	8.87	.1	83.27	Noting time, a continuous variable measuring the time until the first eye fixation on the brand (in seconds). ^e

NOTES:

- a- To make *GAZE* orthogonal to *NOTING*, it is set equal to 0 if the brand is not noted and the average gaze duration (1.02 seconds) is subtracted if the brand is noted.
- b- The default level is when no related brand is noted (always the case for single-SKU brands).
- c- The default level is when no related brand is recalled unaided (always the case for single-SKU brands).
- d- The default level is when the brand was never purchased in the past.
- e- Computed only for brands noted and for consumers noting at least 8 brands (n=1215).

TABLE 2

**STUDY 1: RELATIVE FREQUENCIES AND ASSOCIATION BETWEEN NOTING AND MEMORY
(JOINT AND CONDITIONAL ON NOTING)**

		<i>NOTING</i> (at least one eye fixation)			Measures of association		
		Yes	No	Total	χ^2 (p-value)	Discrimina- tion index (Pr)	Bias index (Br)
<i>UARECALL</i> (unaided recall)	Yes	.19 (.29)	.09 (.25)	.28	4.78 (.03)	.04	.26
	No	.47 (.71)	.26 (.75)	.72			
	Total	.66	.34	1.00			
<i>ARECALL</i> (aided recall)	Yes	.35 (.53)	.16 (.47)	.51	8.05 (< .01)	.06	.50
	No	.31 (.47)	.18 (.53)	.49			
	Total	.66	.34	1.00			

NOTES: Values in parentheses are frequencies within columns (hit and miss rates for brands noted; false alarm and correct rejection rates for brands not noted). Hit rate, $H = P(\text{recall} = \text{yes} / \text{noting} = \text{yes})$ and false alarm rate $FA = P(\text{recall} = \text{yes} / \text{noting} = \text{no})$. $Pr = H - FA$, $Br = FA / (FA + 1 - H)$. $N = 2544$.

TABLE 3
STUDY 1: UNSTANDARDIZED GOLOGIT PARAMETERS AND WALD TESTS

	Aided recall		Unaided recall		Wald tests	
	Parameter (β^1)	Wald test ($\beta^1 = 0$)	Parameter (β^2)	Wald test ($\beta^2 = 0$)	Multivariate ($\beta^1 = 0$ & $\beta^2 = 0$)	Parameter equality ($\beta^1 = \beta^2$)
<i>NOTING</i>	.46	7.81**	.19	1.45	8.28*	3.76*
<i>GAZE</i>	.11	2.86	.14	5.83*	6.49*	.17
<i>NOTREL</i> (pooled)		.05		8.26*	10.18*	8.23*
- <i>NOTREL</i> _{major}	.05	.03	-.63	5.61*	8.02*	6.14*
- <i>NOTREL</i> _{minor}	-.03	.01	.85	3.61*	4.34	3.84*
<i>RECREL</i> (pooled)		6.05*		17.30**	20.06**	8.43**
- <i>RECREL</i> _{major}	.66	6.05*	1.14	16.73**	17.11**	2.80
- <i>RECREL</i> _{minor}	.20	.25	1.20	10.94**	12.47**	6.43**
<i>BRDFAM</i> (pooled)		52.21**		89.11**	93.65**	1.76
- <i>BRDFAM</i> _{medium}	.40	5.09*	.63	11.09**	11.94***	1.33
- <i>BRDFAM</i> _{high}	1.90	49.02**	1.99	78.13**	86.47**	.14

NOTES: *: $p < 0.05$; **: $p < 0.01$.

TABLE 4

STUDY 1: EFFECTS OF ORDER AND TIMING OF ATTENTION (UNSTANDARDIZED GOLOGIT PARAMETERS AND WALD TESTS)

	Aided recall		Unaided recall		Wald tests	
	Parameter (β^1)	Wald test ($\beta^1 = 0$)	Parameter (β^2)	Wald test ($\beta^2 = 0$)	Multivariate ($\beta^1 = 0$ & $\beta^2 = 0$)	Parameter equality ($\beta^1 = \beta^2$)
<i>ORDER</i> (pooled)		6.04*		.72	10.86*	7.48*
- <i>FIRST</i>	.40	1.74	.14	.19	1.74	.53
- <i>LAST</i>	-.70	4.54*	.25	.51	8.17*	7.22**
<i>NOTTIME</i>	.01	1.81	.01	.18	1.93	.82
<i>GAZE</i>	.13	2.28	.18	6.47**	6.71*	.41
<i>BRDFAM</i> (pooled)		27.50*		56.25**	60.29**	.04
- <i>BRDFAM</i> _{medium}	.49	5.93*	.52	4.03*	7.18*	.02
- <i>BRDFAM</i> _{high}	1.93	27.50**	2.00	41.58**	46.88**	.04

NOTES: *: $p < 0.05$; **: $p < 0.01$.

TABLE 5

STUDY 2: HOW TEST LOCATION, BRAND FAMILIARITY, AND BRANDS INFLUENCE NOTING AND UNAIDED RECALL

	df	<i>NOTING</i>			<i>UARECALL</i>		
		Parameter (<i>B</i>)	Wald test (<i>B</i> = 0)	Exp(<i>B</i>)	Parameter (<i>B</i>)	Wald test (<i>B</i> = 0)	Exp(<i>B</i>)
<i>CITY</i> (pooled)	3		22.70**			12.11**	
- <i>CITY</i> ₂	1	-.81	20.17**	.45	.03	.02	1.03
- <i>CITY</i> ₃	1	-.22	1.22	.81	-.25	1.89	.78
- <i>CITY</i> ₄	1	-.45	5.99**	.64	-.50	8.10**	.61
<i>BRDFAM</i> (pooled)	2		6.24*			75.75**	
- <i>BRDFAM</i> _{medium}	1	-.26	3.09	.77	.65	18.25**	1.91
- <i>BRDFAM</i> _{high}	1	.12	.39	1.13	1.63	75.28**	5.08
<i>BRAND</i> (pooled)	9		144.39**			109.17**	
- <i>ALL</i>	1	1.10	17.44**	3.01	.34	1.84	1.41
- <i>SURF</i>	1	-.54	4.66*	.59	-.26	1.07	.77
- <i>A&H</i>	1	.67	6.98**	1.96	-.47	3.27	.63
- <i>YES</i>	1	.19	.59	1.21	-1.22	17.32**	.30
- <i>CLIN</i>	1	.53	4.30*	1.71	-1.43	20.00**	.24
- <i>TIDE</i>	1	1.87	36.29**	6.49	1.30	20.38**	3.66
- <i>PUREX</i>	1	2.41	44.45**	11.17	-.07	.07	.93
- <i>AJAX</i>	1	1.05	15.85**	2.86	-.80	9.00**	.45
- <i>CHEER</i>	1	1.65	33.02**	5.19	.32	1.68	1.38

NOTES: *: $p < 0.05$; **: $p < 0.01$. Nagelkerke's $R^2 = .20$ for *NOTING* and $.29$ for *UARECALL*. $N = 1367$.

FIGURE 1
STUDY 1: SHELF LAYOUT AND CODING



Tropicana Pure Premium		Tropicana Season's Best		
Minute Maid Premium	Minute Maid From Concentrate		Jaffa	Florida's Natural
Sunny Delight	Chiquita	Dole	Tropicana Pure Tropics	Five Alive
Pathmark Premium	Pathmark From Concentrate	Florida Gold Premium	Florida Gold Valencia	Donald Duck

FIGURE 2

STUDY 2: SHELF LAYOUT AND CODING



Wisk	All	Purex	Ajax	Tide
			Cheer	
Surf	Arm & Hammer	Yes	Clin	

FIGURE 3

STUDY 2: AGGREGATE NOTING AND UNAIDED RECALL PROBABILITIES FOR DETERGENT BRANDS

