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Visual attention during brand choice: The impact of time pressure and task motivation

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Abstract

Measures derived from eye-movement data reveal that during brand choice consumers adapt to time pressure by accelerating the visual scanning sequence, by filtering information and by changing their scanning strategy. In addition, consumers with high task motivation filter brand information less and pictorial information more. Consumers under time pressure filter textual ingredient information more, and pictorial information less. The results of a conditional logit analysis reveal that the chosen brand receives significantly more intra-brand and inter-brand saccades and longer fixation durations than non-chosen brands, independent of time pressure and task motivation conditions. Implications for the theory of consumer attention and for pretesting of packaging and shelf lay-outs are discussed.

Keywords: Brand choice; Visual attention; Eye-tracking

1. Introduction

Visual attention is a vital and often the only way to acquire information about brands in consumer choice contexts. Despite its importance, visual attention has been disregarded in marketing research. Research has emphasized consumers' *conceptual* analyses of marketing stimuli, once these have captured the consumer's attention. In conceptual analyses, consumers integrate information from the stimulus with pre-existing knowledge, they imagine events related to the stimulus, and they actively (counter)argue with the position taken by the stimulus (Petty and Cacioppo, 1986; Payne et al., 1993). Before and during conceptual analyses, consumers engage in *perceptual* analyses (Greenwald and Leavitt, 1984) when devoting focal attention to the stimulus. In perceptual analyses, consumers examine sensory features of the stimulus, such as shape, color, and size, they decipher the stimulus into categorical codes, such as brand name, pictorial and textual information for a brand package, and they select certain elements of the stimulus over others. This study focuses on these perceptual analyses of consumers during brand choice, as revealed through patterns of visual attention.

If the poet is right that the eye is the mirror of the soul, consumers' eye-movements should be informative about processes such as attention, information

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acquisition and brand choice. Despite its obvious potential (Kroeber-Riel, 1993), applications of eye-tracking to relevant marketing questions and contributions to theory development have been scarce (d'Ydewalle and Tamsin, 1993; Russo and Leclerc, 1994; Janiszewski, 1998). In their review of consumer decision making, Payne et al. (1993) call for the development and refinement of process-tracing methodologies that allow consumers highly flexible and rapid access to information, and they specifically mention eye-tracking as a potential methodology. This study follows up on their call by examining consumers' visual attention during brand choice, as it is influenced by time pressure and task motivation, two relevant context factors that cover the opportunity and motivation of consumers to acquire and process information (Petty and Cacioppo, 1986). We use eye-tracking methodology, and develop eye-movement measures that build on theories of consumer attention and choice.

Our second objective is to explore the relationship between visual attention and choice. Marketing practitioners and academics share the belief that consumers' attention and in-store brand choice are intimately related. Manufacturers use vivid packaging design to make their brand more noticeable among its competitors. Retailers manage shelf space and special displays to draw attention to products and brands they prefer to sell (cf. Drèze et al., 1993; Allenby and Ginter, 1995). Such attempts rest on the assumption that visual attention is a precondition to subsequent processes that eventually lead to choice, and that increased visual attention will increase the likelihood of choice. Despite the common assumption of a significant association, the attention–choice relationship has never been directly examined. This study examines the relationship between visual attention and choice, and the impact of time pressure and task motivation on the stability of the relationship.

In summary, the study makes two contributions. First, it offers insight into the nature of the adaptation of consumers' visual attention to time pressure and task motivation, using indicators derived from eye-movement data that are intimately linked to the theoretical constructs under study. Second, it documents the nature of the often assumed but rarely examined relationship between visual attention and brand choice.

Before presenting formal hypotheses and the research design, we review the relevant prior research. First, we introduce visual attention as an important component of the brand choice process. Then we discuss the impact of time pressure and task motivation on visual attention, and the attention–choice relationship.

2. Visual attention

Visual attention is conceptualized as a 'window' or 'spotlight' that locally improves the speed and reduces the threshold for processing events. It is manifested as observable motor movements of the eye and head, which ensure that the 'spotlight' of attention illuminates the desired region in space. The spotlight of visual attention follows a scanpath over the stimulus, consisting of fixations and saccades, and several smaller corrective eye-movements. Saccades are quick jumps from location to location during which vision is essentially suppressed (Sperling and Weichselgartner, 1995). Fixations are the pauses between saccades during which the eye is relatively immobile, and during which the visual system gathers information. The duration of fixations is variable, ranging from 50 milliseconds to over a second. Fixation duration depends on task and subject characteristics, and averages between about 200 and 400 milliseconds (Rayner, 1994).

In this study, we measure consumers' eye-movements while they are choosing from a naturalistic choice display with six brands of a common packaged goods category, shampoo. We assess fixations on, and saccades between, brands and between meaningful areas of each brand's package. This allows us to observe variability in the pattern of fixations and saccades between consumers and between brands, and to investigate whether this variability is systematically related to constraints on decision time and task motivation, and to the choices consumers make.

Past decision research has found that decision-makers strategically adapt information acquisition about choice alternatives to situational and individual-specific constraints. However, decision making has been studied traditionally with information display board (IDB) methodology, and one is left won-

dering whether adaptiveness generalizes to common consumer purchase environments in which information is less structured and acquisition is likely to be less strategic. First, IDB methods provide subjects with information about alternatives in a structured matrix format, in which it is easy to find where relevant information is located. The methods also reduce products or brands to comparable bundles of attributes, making abstraction of a host of 'irrelevant features' such as package colors and shapes which, in more naturalistic situations, have a high potential to draw free-flowing attention. In addition, even the fast, electronic versions of IDB methodology, such as MouseLab (Payne et al., 1993), operationalize information acquisition as a sequence of discrete, intentional and controlled information acquisition 'acts', each of which obtains a value of a cell in the predefined attribute-alternative matrix. In contrast, the scanpath of visual attention is not entirely under voluntary control, but partially driven by automated scanning routines and the attention-drawing features of the display (Lévy-Schoen, 1981; Janiszewski, 1998). IDB methodology cannot capture these processes. A legitimate question is therefore whether findings from the decision making literature hold in situations where information acquisition is largely limited to visual inspection of brand packages as they are found in the store. There are three possibilities.

First, perhaps visual attention does not reflect the same strategic adaptations as does the acquisition behavior in IDB methodology, simply because there is no deliberate control. This would mean that the view of adaptive human decision making, represented in the work of Payne et al. (1993) is overly optimistic. Taken to a naturalistic decision making situation, information acquisition would not be adaptive to contextual constraints. Second, one may argue that the dogmatic view of eye-movements reflecting higher order mental processes is untenable (see Viviani, 1990). Therefore, only the adaptive thought processes captured by IDB methodology and similar methods would be relevant to real world choice. Visual attention would then not systematically adapt to the constraints, and there would be no systematic relationship between visual attention and choice. Third, it may be that the perceptual processes captured by eye-movements are reminiscent of strategic information processing. This third possibility, which we explore in this study, would not imply that eye-movements are entirely deliberate, but it would imply that visual attention measures contain information about strategic adaptations to contextual constraints, and about consumers' choices.

3. Time pressure and task motivation

Many decisions are made under time pressure, with insufficient time to collect complete information and to weigh all pros and cons extensively. Time pressure regulates the amount of information that can be processed, and its impact on consumer decision making is significant (Iyer, 1989). Since research about the impact of time pressure on visual attention is lacking, we will use findings about information acquisition in decision making as a point of departure. Consumers appear to use at least three strategies to cope with time pressure: by accelerating information acquisition, by filtering part of the available information, and/or by shifting their information acquisition strategy.

Acceleration occurs when consumers speed up information collection and processing. One way to accelerate the rate of visual information acquisition is by reducing the duration of individual fixations on the stimulus. In a relevant study, Lévy-Schoen (1981) found that the average fixation duration of individuals who read a text slowly was 287 milliseconds, compared to an average fixation duration of 247 milliseconds for individuals who read at their normal pace. The reverse effect of speeding up reading was not investigated, but appears likely.

Filtration occurs when consumers become more selective in the face of time constraints. Filtration in visual attention is demonstrated when consumers skip certain elements of information about the brands in the display, or do not fixate some brands at all. The decision to skip elements is based on global expectations about the types of information in different locations of the brand display and on parafoveal and peripheral attention during scanning (Janiszewski, 1998).

Finally, a *strategy shift* occurs when consumers adopt modes of information acquisition that are faster and easier to implement. Decision making research

indicates that under time pressure, consumers shift from compensatory to simpler, non-compensatory rules, and from processing-by-brand to processing-by-attribute (Payne et al., 1993; Edland, 1994). Processing-by-attribute increases the likelihood that all alternatives are scanned at least partially within the time available for task completion, and is cognitively less taxing. Visual attention patterns provide insight into processing and information acquisition strategies, since saccades within brands (intra-brand saccades) indicate information acquisition by brand, and saccades between brands (inter-brand saccades) indicate information acquisition by attribute.

Research shows that when task motivation is high, consumers spend more time acquiring information (Celsi and Olson, 1988), scrutinize the message arguments more extensively, and base their overall evaluation more on message arguments than on non-message cues (Petty and Cacioppo, 1986). Individuals with high task motivation also appear to use more compensatory processing (Irwin and Smith, 1957). So, the impact of task motivation on visual attention during brand choice appears complementary to the impact of time pressure. Specifically, we expect highly motivated consumers to decelerate information acquisition, as evidenced by longer fixation durations. We also expect them to attend to more elements of the stimulus, as evidenced by a lower frequency of skipping, and to use more information acquisition by brand, as evidenced by higher numbers of inter-brand saccades.

The literature on attitude formation and decision making (Petty and Cacioppo, 1986; Payne et al., 1993) leads us to expect that the effects of motivation and time pressure effects are additive under normal viewing conditions: less opportunity under time pressure is compensated by more motivation, and vice versa. We do not exclude that non-additive effects occur if both motivation and time pressure are at extremely high levels. Under these affective 'stress' or 'panic' conditions, information acquisition and adaptive cognitive processing may break down in unpredictable ways (Janis and Mann, 1977). Since these extreme conditions do not apply to most regular shopping situations, our study is limited to realistic ranges for both variables. Hence, an interaction between time pressure and motivation is not expected, resulting in the following two hypotheses.

Hypothesis 1. Increased time pressure leads to acceleration, more filtration, and to more information acquisition by attribute and less by brand, as expressed through decreased fixation durations, increased skipping of brand elements, increased inter-brand saccades, and decreased intra-brand saccades, respectively.

Hypothesis 2. Increased task motivation leads to deceleration, less filtration, and to less information acquisition by attribute and more by brand, as expressed through increased fixation durations, decreased skipping of brand elements, decreased inter-brand saccades, and increased intra-brand saccades, respectively.

4. Visual attention and brand choice

Hypotheses 1 and 2 are supported when differences between time pressure and motivation conditions are observed on the mean values of visual attention for the set of brands taken as a whole. A second issue is whether the final choice of a brand from a set can be predicted from the indicators of visual attention. Recently, Russo and Leclerc (1994) examined consumers' visual attention during brand choice. While consumers made brand choices from simulated store shelves, their faces were videotaped through a one-way mirror. Inter-brand saccades were determined from the videotapes by two judges. The results showed that the number of inter-brand saccades including the chosen brand was significantly above chance levels, because a single brand emerged as superior in pairwise comparisons.

Methodological restrictions prevented Russo and Leclerc (1994) from analyzing intra-brand saccades, but their results and those of others (cf. Van Raaij, 1977) suggest that the chosen brand also receives more intra-brand saccades. Choice from a set of brands is frequently a multi-strategy process, in which consumers engage in processing-by-attribute to reduce the choice set to a manageable set, and in which they engage in processing-by-brand to make a balanced final choice, using various decision heuristics (Roberts and Nedungadi, 1995). In such multi-strategy choice processes, the chosen brand will be engaged in more processing-by-brand than non-cho-

sen brands, which results in a higher number of intra-brand saccades. In a similar vein, it is likely that compared to non-chosen brands, the chosen brand will be scanned more completely. Exclusion of brands from the set in early stages will frequently be based on partial information (Payne et al., 1993). This suggests that compared to non-chosen brands, subjects will skip fewer information elements of the chosen brand.

Predictions about the relationship between fixation duration and choice are more difficult to make. Research indicates that both children and adults tend to gaze longer at attractive as compared to unattractive faces, and that both prefer attractive faces (Dion, 1977). In the present context, this suggests that fixation duration and choice will be positively related. We offer the following hypothesis.

Hypothesis 3. Visual attention is positively related to brand choice, as expressed by longer fixation durations, less skipping of brand elements, more intra-brand saccades, and more inter-brand saccades for the chosen brand, compared to the non-chosen brands.

Our final question is whether the relationship between visual attention and choice is moderated by time pressure and task motivation. Moderating effects of task motivation and time pressure on the attention–choice relationship occur if the *distribution* of the visual attention indicators across the chosen and the non-chosen brands is significantly affected. Potential moderating effects are indicated by dotted lines in Fig. 1. Homogeneity of the attention–choice relationship across levels of task motivation and time pressure would make brand choice prediction from visual attention data straightforward, and would be convenient to managers and researchers interested in influencing choice, because these conditions are usually not under marketer control.

It is not obvious why moderating effects on the attention–choice relationship would occur. One might argue that task motivation and time pressure might reduce visual exploration that is not directly related to the final choice. The attention–choice relationship would then be strengthened, while it would be weakened under the reverse conditions. However, increased or decreased visual exploration would only influence the attention–choice relationship if it would affect the chosen and non-chosen brands *differentially*, and our examination of the literature does not lead to such predictions. In fact, most research to date suggests that the relationship between visual attention and its antecedents and consequences is robust under a number of environmental and individual differences. Testing hypotheses derived from scanpath theory, Rosbergen et al. (1998) found that patterns of visual attention to print advertising were stable across ad repetitions and levels of consumer motivation. Russo and Leclerc (1994) observed that the relationship between inter-brand saccades and choice is stable across individual difference variables such as product category purchase frequency. In related research, Loftus (1983) found across multiple stimuli and conditions that the relationship between fixation frequency and memory was stable. Consequently, the following hypothesis is offered.

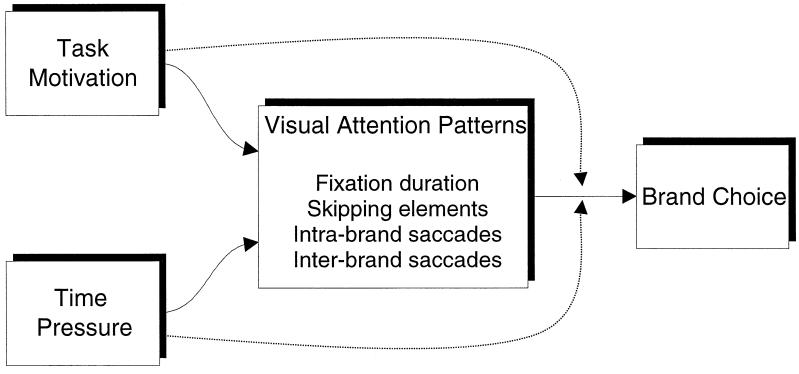

Fig. 1. Conceptual framework.

Hypothesis 4. The relationship between visual attention and brand choice is stable across time pressure and task motivation conditions.

Joint support for all hypotheses would imply that while visual attention to the choice set *as a whole* adapts to situational and motivational constraints, the relationship between visual attention to and choice for a *specific brand* from the set is stable across such conditions. This would mean that the eye is not just the mirror of the soul, but that the mirror provides a robust image.

5. Method

5.1. Subjects

A total of 52 female and 12 male Dutch subjects ranging in age from 20 to 49 years were invited to participate in the study by a marketing research company. A session lasted approximately 30 minutes. Subjects were paid Fl 20 (approximately $12) for their participation. Due to incomplete eye-recordings and insufficient calibration, the data from 10 subjects had to be dropped from the database (attrition was not systematic across conditions, $\chi^2(1) < 1$). The final number of subjects per cell is 11 in low time pressure–low task motivation, 12 in low time pressure–high task motivation, 15 in high time pressure–low task motivation, and 16 in high time pressure–high task motivation. All subsequent analyses are based on the 54 subjects for whom complete eye-movement data are available.

5.2. Design and stimuli

The stimuli were four color-slides each showing a choice set consisting of packages of six brands in four product categories: rice, shampoo, canned soup, and salad dressing. All brands were marketed in the Dutch-speaking part of Belgium but not in the Netherlands, and unknown to our subjects. All four choice sets were displayed similarly to how they are typically located on store shelves. Three of the four sets were displayed as two rows of three brands. The salad dressing bottles, due to their height, were displayed as one row of six brands. All packages were clearly visible, and large enough such that the verbal information on the packages was clearly readable. The target slide pictured the shampoo bottles. It is shown in Fig. 2.

The experiment was run as a 2×2 (Time Pressure $\times$ Task Motivation) between-subjects design. In the low time pressure condition, each slide was presented for a maximum duration of 20 seconds. A pilot study had shown this to be sufficient to inspect all brands on a slide in detail. Instructions in this condition emphasized that subjects would have enough time to inspect the slide at their own pace. In the high time pressure condition, each slide was presented for a maximum of 7 seconds. The instructions mentioned that the subjects would not have much time to inspect the slides.

Task motivation was manipulated in two ways. Prior to presentation of the first slide, subjects in the high task motivation condition read that the study's purpose was to test a number of brands that were about to be introduced on the local market, and that their evaluation of the brands was valued highly. Subjects were promised a choice from a number of brands of shampoo as a reward for their participation (cf. Petty and Cacioppo, 1986). Subjects in the low task motivation condition were told that the study was part of the development of a new product test, and they were not promised an extrinsic reward.

5.3. Tracking procedure

Subjects participated individually. Upon entering the experimental room, they read a booklet with the instructions. They were informed that a camera would record their eyes while they made a choice between brands from various product categories. An explanation of the study's objectives followed, including the task motivation manipulation. Then the subjects were seated in front of the screen on which the stimulus slides would be projected from behind. The center of the screen, which measured 70×70 cm, was located at the consumer's eye height. The distance between the eyes and the screen was 120 cm. The subjects placed their head on a small headrest, while an infrared camera located below the projection screen recorded their eye-movements. The camera was calibrated on the subject's right eye. During measurement, the position of the fovea was recorded 50

Fig. 2. The brand display.

times per second, by infrared corneal reflection (cf. Young and Sheena, 1975).

The stimulus slides were projected on the screen intermittently from two Kodak Ektapro 9000 slide projectors with Doktor PC lenses and fast shutters. The onset of each slide was announced through small speakers located left and right from the subject's head. The target slide (shampoo) was always in second position. Subjects pressed a 'continue' button when they were done, in order to see the next slide. After each slide with brands, subjects saw a slide with six boxes, labeled A through F, whose locations corresponded to those of the previous brand. Subjects indicated their choice for a brand by naming the letter of the box that corresponded to the chosen brand. Slide projectors, auditory instructions, recording of brand choices, and eye recording were computer controlled.

5.4. Measures of visual attention

Consistent with recent eye-movement research (Rosbergen et al., 1997), the focus in this study is on visual attention to specific relevant areas of the stimulus display, instead of on exact x and y coordinates of individual fixations. We define as relevant areas the brands as a whole, as well as the three major elements within each brand's package, i.e., brand name, ingredient information, and pictorial. As shown in Fig. 3, each shampoo bottle is defined as a separate major area of the display (areas A through F). Within each of these major areas three sub-areas are defined. Each sub-area corresponds to a salient element of the package: brand name (areas I, L, M, Q, T and V), pictorial (areas G, K, N, R, S and X), and ingredient information (areas H, J, O, P, U and W).

Intra-brand saccades are defined as all jumps of the eye from one area of a particular brand to another area of the same brand. *Inter-brand saccades* are defined as all jumps from an area of a particular brand to an area of another brand. Average *fixation duration* is defined as the mean of all individual fixation durations on a particular area of the brand, or on the brand as a whole. Finally, areas of a

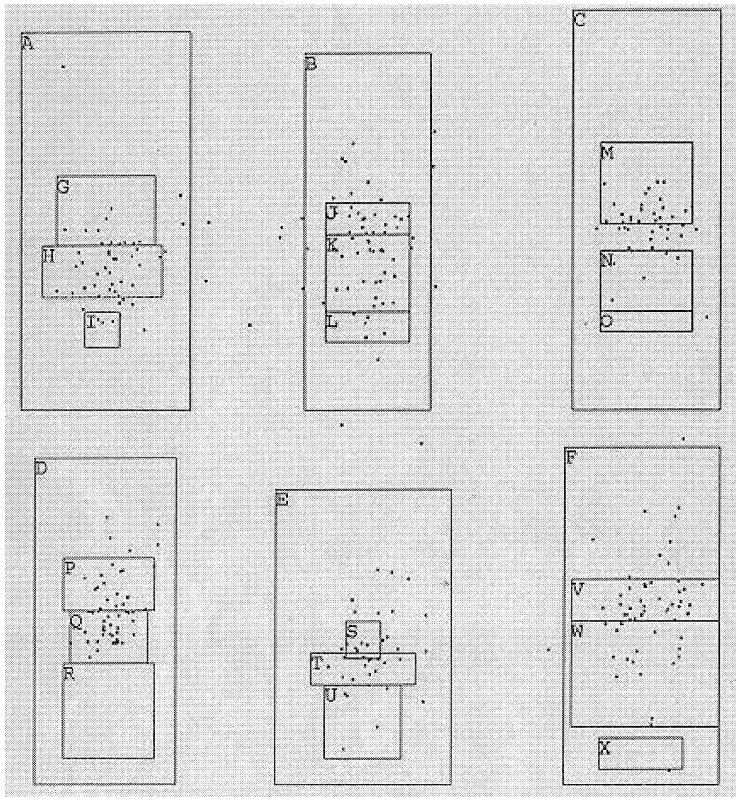

Fig. 3. Information elements on the brand display.

brand that receive no fixations at all are *skipped* (see Pieters et al., 1997 for alternative measures). Fig. 4 shows a hypothetical scanpath to illustrate our visual attention measures.

In the hypothetical scanpath, there are four intra-brand saccades (G–H, H–I, K–J and J–K), and two inter-brand saccades (I–K and K–M). The average fixation duration on brand A is the mean of all

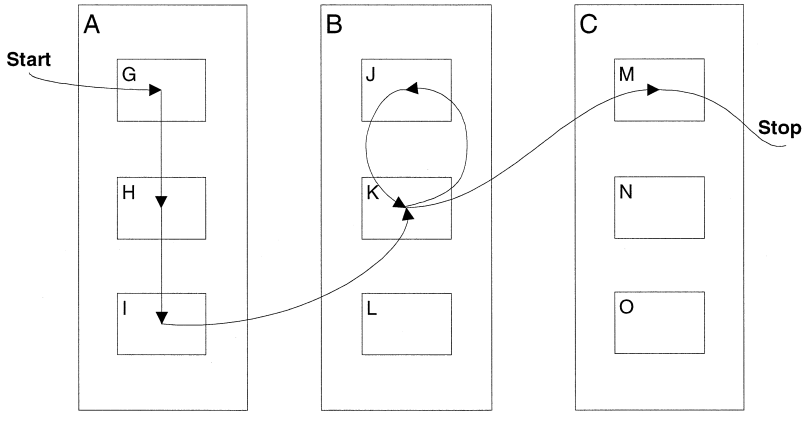

Fig. 4. A hypothetical visual attention pattern.

fixation durations on areas G, H and I. The average fixation duration on brand B is the mean of the durations of the fixations on areas K, J and again K. As there is only one fixation on an area of brand C, its average fixation duration is the duration of the fixation on M. In total three areas are skipped (L, N and O).

5.5. Verbal measurement procedure

After the final choice, subjects completed a questionnaire. First, memory for the brands and products on the slides was assessed. Second, subjects answered manipulation check questions. Next, they saw the slide with the six shampoo brands again, and were asked to indicate preference for each of the brands. In all cases, the most preferred brand corresponded to the brand chosen earlier.

In the memory task, subjects were asked to recall everything they could remember of the products and brands on the four brand displays they had been exposed to (product and brand names, form, color and textual elements. The total number of elements that subjects recalled from the shampoo slide is the measure of memory.

Manipulation checks included measures of experienced time pressure, arousal, and task motivation. The experienced time pressure item read 'To thoroughly inspect the slide with the six products, I had...' with a 7-point response scale from 'much too little time' (-3) to 'much too much time' $(+3)$. If time pressure affects subjects' arousal in addition to their processing capacity, potential differences between time pressure conditions can not be unequivocally attributed to capacity limitations (Pham, 1996). Three items in the questionnaire assessed consumers' arousal during the task. The items read 'During the study I was...' with a 7-point response scale from 'very nervous' (-3) to 'not nervous at all' $(+3)$, 'For some reason I do not feel very much at ease at the moment' with a 7-point response scale from 'completely disagree' (-3) to 'completely agree' $(+3)$, and 'Participating in this study was...' with a 7-point response scale from 'not at all exciting' (-3) to 'very exciting' $(+3)$. The items tap different aspects of positive and negative arousal during and after the visual attention and choice task.

Five items from the involvement scales of Kapferer and Laurent (1985) and Jain and Srinivasan (1990) were used to assess the success of the motivation manipulation. The items read: 'When choosing a brand of shampoo, it is not a big deal if you make a mistake', 'Choosing the wrong shampoo is annoying', 'If the shampoo that I have bought turns out to be the wrong one, I would feel bad about it', 'Choosing shampoo is difficult', 'I'm completely uninterested in shampoo'. All items were accompanied by 7-point response scales ranging from 'completely disagree' (-3) to 'completely agree' $(+3)$. Because the five items form a single factor as indicated by a confirmatory factor analysis ($\chi^2(5) = 1.086$, $p = 0.90$; CFI = 1.00, TLI = 1.17), they were averaged (coefficient alpha = 0.681).

In the debriefing, none of the subjects guessed the true purpose of the study, nor showed any insight in the task motivation manipulation.

6. Results

6.1. Manipulation checks

Subjects in the high time pressure condition pressed the 'continue' button faster than subjects in the low time pressure condition (respective means 6.55 vs. 18.82 seconds; $F(1,50) = 9084.26$, $p < 0.001$). Subjects in the high time pressure condition indicated to have less time to inspect the target slide than subjects in the low time pressure condition (-0.813 vs. 0.652, $F(1,50) = 18.938$, $p < 0.001$). Subjects in the high time pressure condition also recalled significantly less elements from the brand than subjects in the low time pressure condition (0.968 vs. 1.652, $F(1,50) = 5.935$, $p < 0.02$). Time pressure did not raise subjects' arousal, as no differences between conditions were observed in feeling nervous ($F(1,50) = 1.177$, $p < 0.29$), feeling at ease ($F(1,50) < 1$) and feeling excitement ($F(1,50) = 1.250$, $p < 0.27$). Subjects in the high motivation condition scored significantly higher on the measure of involvement than subjects in the low motivation condition (respective means 1.700 vs. 0.854, $F(1,50) = 9.369$, $p < 0.005$). This indicates that the experimental manipulations were successful in creating differences in felt time pressure and task motivation. Potential differences between time pressure conditions are due to differences in processing capacity

and not due to differences in subjects' arousal (Pham, 1996) or psychological stress (Svenson et al., 1990).

6.2. Influence of time pressure and task motivation on visual attention to brands

In the first stage of the analyses, the effect of time pressure and task motivation on visual attention to the brand display was analyzed using measures for the brand display as a whole. Average fixation duration of all fixations on the brands in the display was determined. The number of elements skipped in the display as a whole was calculated (minimum = 0, maximum = $6 \times 3 = 18$). The number of intra- and inter-brand saccades across all six brands *per second* was calculated to control for individual differences in exposure duration. Means of the visual attention measures in the cells of the experimental design are presented in Table 1, and the results of analyses-of-variance on the measures are presented in Table 2.

As hypothesized, consumers under high time pressure did speed up information acquisition. The average fixation duration was 354 milliseconds under high time pressure and 431 milliseconds under low time pressure ($F(1,50) = 12.71$; $p < 0.001$). Consumers also filtered significantly more under high time pressure; specifically they skipped more brand areas under high time pressure (9.097) than under low time pressure (4.435; $F(1,50) = 92.75$; $p < 0.001$). Significant strategy shifts under high time pressure were observed as well. Under high time pressure, consumers emphasized processing-by-brand, by increasing the number of inter-brand saccades from 0.799 to 1.234 per second ($F(1,50) = 25.21$; $p < 0.001$). However, the increase in inter-brand saccades was not at the expense of the number of intra-brand saccades, which remained largely constant (1.510 under low time pressure vs. 1.478 under high time pressure).

Overall results for task motivation are similar, but with some interesting differences. As hypothesized, the average fixation duration increased under high task motivation (from 368 milliseconds to 404 milliseconds ($F(1,50) = 2.86$; $p < 0.05$), indicating deceleration of information acquisition. Counter to the hypothesis, the number of brand elements skipped did not differ between low and high task motivation conditions (7.000 and 7.214, respectively). As hy-

Table 1
Impact of time pressure and motivation on visual attention: means

Visual attention measures	Total sample	Time pressure		Task motivation		Low time pressure		High time pressure	
		Low	High	Low	High	Low task motivation	High task motivation	Low task motivation	High task motivation
Acceleration									
Fixation duration (ms)	386	431	354	368	404	426	435	325	380
Filtration									
Brand elements skipped ($n = 0$–18)	7.111	4.435	9.097	7.000	7.214	4.545	4.333	8.800	9.375
Proportion brand name	0.361	0.358	0.362	0.402	0.322	0.410	0.311	0.396	0.331
Proportion ingredient information	0.195	0.125	0.248	0.197	0.194	0.119	0.130	0.255	0.242
Proportion pictorial	0.444	0.517	0.390	0.401	0.484	0.471	0.559	0.349	0.427
Strategy shift									
Intra-brand saccades (n/s)	1.492	1.510	1.478	1.464	1.518	1.539	1.483	1.408	1.544
Inter-brand saccades (n/s)	1.049	0.799	1.234	1.191	0.917	0.821	0.778	1.463	1.020
Cell size	54	23	31	26	28	11	12	15	16

Table 2
Analyses of variance on visual attention measures

Visual attention measures	Time pressure[a]		Task motivation		Interaction	
	F value	*p*	*F* value	*p*	*F* value	*p*
Acceleration						
Fixation duration	12.714	< 0.001	2.855	0.049	1.143	0.145
Filtration						
Brand elements skipped	92.751	< 0.001	0.141	0.355	0.665	0.210
Proportion brand name	0.008	0.464	5.948	0.009	0.270	0.303
Proportion ingredient information	13.542	< 0.001	0.001	0.487	0.136	0.357
Proportion pictorial	8.394	0.003	3.577	0.032	0.013	0.455
Strategy shift						
Intra-brand saccades	0.101	0.376	0.127	0.362	0.759	0.194
Inter-brand saccades	25.215	< 0.001	7.585	0.004	5.171	0.014

[a]All *df*'s are 1,50. Main effect *F*-tests are one-tailed. Interaction tests are two-tailed.

pothesized, the number of inter-brand saccades per second decreased under high task motivation, from 1.191 to 0.917 ($F(1,50) = 7.59$; $p < 0.01$), which indicates decreased emphasis on processing-by-attribute. As with time pressure, we observed no differences in intra-brand saccades between low and high task motivation.

The interaction between time pressure and task motivation was significant for the number of inter-brand saccades per second ($F(1,50) = 5.171$, $p < 0.02$). Post-hoc tests (Tukey HSD at $p < 0.05$) revealed that the number of inter-brand saccades per second for subjects in the high time pressure–low task motivation condition (1.463) was higher than in the other cells of the experimental design. The other cells did not differ significantly from each other. Visual attention in the high task pressure–low task motivation condition tended to jump more from brand to brand. Hypotheses 1 and 2 were largely supported, with the exception of unexpected null results for the number of skipped elements as a function of motivation, and for intra-brand saccades as a function of both motivation and time pressure. We will return to these results in Section 7.

We conducted an additional exploratory analysis on the nature of the skipped brand elements in the different conditions. For each subject, the proportion of skipped brand elements that were either the brand name, or the ingredient information or the pictorial was determined. The average proportions are indicated in Table 1. They sum to 1.00 per condition. The analyses reveal no differences between time pressure conditions in skipping the brand name, but significant differences in skipping the ingredient information and the pictorial. Specifically, under high time pressure the proportion of textual, ingredient information skipped was higher (0.248 vs. 0.125, $F(1,23) = 13.54$; $p < 0.001$) and the proportion of pictorials skipped was lower (0.390 vs. 0.517, $F(1,23) = 8.39$; $p < 0.01$). Apparently, consumers focused on the cognitively less taxing pictorial information and skipped the cognitively more taxing textual information under time pressure. This result indicates that skipping of brand elements under time pressure is non-random, and that information costs are one determinant of the rapid selections consumers make within the seven seconds they had available under time pressure.

Significant differences between task motivation conditions were observed in skipping brand name and pictorial information, but not in skipping ingredient information. Specifically, under high task motivation the proportion of skipped elements which are brand names was lower (0.322 vs. 0.402, $F(1,23) = 5.95$; $p < 0.01$) and the proportion of skipped elements which are pictorials was higher (0.484 vs. 0.401, $F(1,23) = 3.58$; $p < 0.05$). Skipping of brand elements under task motivation appears non-random,

Table 3
Effect of visual attention on brand choice: conditional logit analysis

Parameter	Coefficient	Standard error	p	Mean of chosen brand	Mean of non-chosen brands
Fixation duration	0.0021	0.0009	0.018	52.932	−10.586
Brand elements skipped	−0.5224	0.3451	0.130	−0.445	0.088
Intra-brand saccades	0.3144	0.0913	0.001	2.210	−0.424
Inter-brand saccades	0.5307	0.1456	< 0.001	1.055	−0.212
Number of observations	324			54	270
Log-likelihood	−62.206				
χ^2 (df) p	69.10 (4), $p < 0.001$				
Pseudo R^2	0.357				
BIC	−45.975				

and is determined by the consumers' goals. Under high task motivation, brand names are relevant for the future choices consumers expect to make, and therefore they are skipped less.

6.3. Predicting brand choice from visual attention

In the second stage of the analysis, we examine whether brand choice can be predicted from consumers' visual attention to each of the six brands in the display. Fixation duration, skipped brand elements, intra-brand and inter-brand saccades are used as measures of visual attention. Each consumer devoted visual attention to each of the six brands in the display, and chose one brand out of the six in the set. The number of times each of the six brands was chosen is as follows: brand A 6 times, brand B 13 times, brand C 9 times, brand D 7 times, brand E 15 times and brand F 4 times.

Because a set of dependent and independent variables is available for each consumer and for each brand in the display, a conditional logit model (McFadden, 1973; Long, 1997) was estimated, [1] using maximum likelihood, in the program Stata (1997). Our interest was not in predicting which specific brands are chosen over others, but whether the choice of a specific brand by a consumer can be predicted from information on his/her visual attention to each of the six brands in the display. Prior to the analysis, each of the four visual attention measures was centered around its respective mean value for each subject. Centering accounts for differences in the mean levels of the visual attention measures between subjects due to time pressure and motivation conditions. Hence, coefficients in the analysis express the effect that deviations in visual attention measures from the subject-mean have on the likelihood of choosing a brand. Pseudo R^2 and BIC measures are used to assess the fit of the model (Long, 1997). [2] Table 3 displays means of the visual attention measures for chosen and non-chosen brands, and the results of the conditional logit analysis.

The results support Hypothesis 3. Three of the four visual attention measures have a significant positive effect on brand choice, and the effect of the fourth variable, skipping brand elements, is in the expected, negative direction. The overall fit of the

[1] The conditional logit model (CLM) is closely related to the multinomial logit model (MNLM), and algebraically equivalent (Long, 1997, pp. 178–182). Yet, in the MNLM, with J nominal outcomes, there are $J-1$ parameters for each independent variable, but only a single value of each independent variable for each subject. In the CLM there is a single parameter for each independent variable, but J values of each independent variable for each subject.

[2] Pseudo R^2 is defined as $1-\ln L_1/\ln L_0$ (Long, 1997, p. 104), and BIC is defined as $-2(\ln L_1-\ln L_0)+df\cdot\ln N$, with df equal to the number of regressors (Long, 1997, Eq. (4.14), p. 111), in which L_0 is the likelihood of the null model without predictors, L_1 is the likelihood of the model with predictors, N is the number of observations. The more negative the value of BIC, the better the model is, compared to the null model. A BIC of zero indicates that the estimated model does not fit better than the null model, given the number of regressors it requires.

simple attention model is substantial, as expressed by a pseudo R^2 of 0.357 and a BIC of -45.975, which are obtained with four simple measures of visual attention only. Inspection of Table 3 indicates that average fixation duration on the chosen brand is almost 53 milliseconds longer than the average fixation duration on the non-chosen brands. This is substantial in view of an overall fixation duration of 386 milliseconds in the sample as a whole (see Table 1). Also, the chosen brand receives on average about 2.1 intra-brand saccades, and on average 1.1 inter-brand saccades more than non-chosen brands do. The effect of the number of brand elements skipped is not statistically significant, but it is in the expected direction (-0.45 elements skipped less in the chosen brand).

To test Hypothesis 4 that the effect of visual attention measures on brand choice is stable across task motivation and time pressure conditions, an additional conditional logit model was estimated. In the second model, the 12 interactions between the four visual attention measures and the experimental conditions (task motivation and time pressure, both effect coded, and their interaction) were added to the first model with only the four attention measures. If the effect of visual attention is stable across the experimental conditions, the second model should not be a significant improvement over the first model in predicting brand choice. This is what we found. The log-likelihood of the second model is -57.598. The improvement over the simple attention model is not significant ($\Delta\chi^2(12) = 9.21,\ p = 0.68$). The BIC of this second model is $+14.178$, which is worse than the first model, and even worse than the null model without predictors. Also, none of the coefficients of the 12 interaction parameters in model 2 is statistically significant at $p < 0.05$. These results support Hypothesis 4.

7. Discussion

Eye-tracking offers new opportunities to develop descriptively accurate process theories of consumer information acquisition and decision making because it allows fine-grained measurement of natural attentional flow and intensity. It can be used to observe choice of naturally occurring stimuli, such as real brand packaging. This allows systematic study of variables such as display characteristics or package design, which are known to influence consumer attention in the field, but for which the arsenal of traditional methods of the decision researcher is insufficient (Payne et al., 1993).

Until recently, collecting and analyzing eye-movement data was cumbersome, and grounding eye-tracking measures in substantive theory proved difficult (Rayner, 1994). In response, researchers interested in visual attention frequently relied on human observation of eye-movements through one-way mirrors (Russo and Leclerc, 1994) or reported scanpaths without further analysis (Kroeber-Riel, 1993). This is one of the first studies to examine the role of visual attention in brand choice using theoretically grounded, simple measures derived from infrared eye-tracking. The intricate information acquisition patterns obtained through eye-tracking are not easily obtained with traditional process-tracing procedures, and assessing fixation durations is unique to eye tracking.

The results show that visual attention adapts rapidly to differences in time pressure and task motivation, two important contextual factors. Under high time pressure consumers accelerated information acquisition as indicated by the decreased average duration of their eye fixations. They also filtered information by skipping information elements on the brands. Filtering is non-random, as in particular the textual information elements of the brands were skipped more. Under high time pressure consumers also shifted to a processing-by-attribute strategy, indicated by increasing numbers of inter-brand saccades. Highly motivated consumers decelerated information acquisition, indicated by higher average fixation durations, and they de-emphasized processing-by-attribute indicated by reduced levels of inter-brand saccades. While we did not find overall differences in the number of skipped brand elements between task motivation conditions, significant differences were found in the nature of skipped elements. Specifically, when motivation was high consumers skipped less of the brand names and more of the pictorial elements. We believe that these results are even more encouraging since we used real brands for which the size and location of each of the brand elements on the bottles differed. Therefore, the sys-

tematic filtering that we observed cannot be due to simply deleting a whole row or column in the brand display, as is possible in attribute-alternative matrices.

This study offers convincing support for the hypotheses that consumers react to decreased opportunity and increased motivation by changing their information acquisition patterns in systematic ways. The speed and complexity of the processes were striking, as the high time pressure condition gave consumers only seven seconds to scan the brand display, and to choose. The study also shows that brand choice can be predicted from observations of visual attention patterns only. Specifically, the conditional logit model revealed that fixation duration, intra-brand saccades, and inter-brand-saccades predict brand choice. Brands that are fixated longer, that receive more intra-brand saccades, indicating processing-by-brand, and that are engaged in more inter-brand saccades, indicating processing-by-attribute, have a higher likelihood of being chosen. The effects of fixation duration, intra- and inter-brand saccades on choice of a *specific brand from the set* were stable across time pressure and task motivation conditions, which were shown to have significant effects on consumers' visual attention patterns with respect to the *set of brands as a whole*. This result is theoretically important and practically re-assuring to managers and researchers interested in the attention–choice relationship, since it means that the relationship is not volatile to differences in personal and environmental conditions that are typically beyond managerial control.

Some results were unexpected, and several questions remain. First, the number of intra-brand saccades appeared insensitive to either time pressure or motivational differences. Given our observation of qualitative differences in the nature of inter-brand saccades, it is unlikely that this null-result reflects the absence of adaptiveness. Perhaps the null-effect is due to differential sensitivity of intra- and inter-brand saccades to contextual factors. Differential sensitivity is strategic when subjects increase processing-by-attribute to obtain a picture of all brands in the set under low to moderate time pressure, and only decrease processing-by-brand and lose a complete picture of each brand under higher levels of time pressure. This hypothesis may be tested in future research using different and more extreme levels of time pressure than in the present study.

Also, an unexpected interaction between time pressure and motivation for the number of inter-brand saccades emerged. Specifically, less motivated–high time pressure subjects expressed more inter-brand saccades than the other subjects did. This result might be due to a floor effect on the minimal number of inter-brand saccades that would be expected for unconstrained visual scanning of a display. Further research is needed to clarify this issue.

Finally, choice was statistically unrelated to the number of skipped elements within a brand, although the effect was in the predicted direction. Further research will have to examine whether this is a range restriction effect due to the limited number of areas that we were able to specify in this study.

7.1. Implications and future research

Before judging the quality and valence of information contained in commercial stimuli, consumers have already been very active in filtering out information elements, allocating attention preferably to particular elements, and in comparing information elements within and across brands. The outcomes of these perceptual analyses are significantly and systematically related to personal and environmental conditions, and they are predictive of choice. Of course perceptual and cognitive processes mutually influence each other, and they are not ordered strictly, nor can they be separated completely. Yet, the present results do underline the relevance of studying the perceptual processes consumers are engaged in prior to engaging in the more higher level cognitive processes that have been the mainstay of consumer behavior research.

Interesting exploratory results were obtained for the filtration patterns due to time pressure and motivation. Highly motivated consumers were more likely to skip the (purportedly) less informative pictorial on the product packages, and were more likely to concentrate on the brand name, which is essential information for making a choice. Also, time pressured individuals tend to avoid the cognitively taxing ingredient information and they tend to prefer the less taxing pictorial information. The Elaboration Likelihood Model (Petty and Cacioppo, 1986) predicts

complementary effects of opportunity (time pressure) and motivation (task motivation) on evaluation, specifically on following a central or peripheral route to attitude formation and change. The present results indicate that opportunity and motivation do not have complementary effects on components of the information acquisition processes. While further research is needed to corroborate the findings, they suggest that the effects of environmental conditions vary by the analysis stage (perceptual or conceptual) that consumers are engaged in. Future research could vary orthogonally the information value and the visual attractiveness of textual and pictorial features on brand packages, and examine to which extent both influence the perceptual selections early in the choice process, and the resulting choices. Our results can serve as a suggestive point of departure.

Attention theorists draw a distinction between control of attention at the global level and control at the local level (Lévy-Schoen, 1981; Rayner, 1994). Global control refers to all factors that influence how a display is scanned (such as time pressure and task motivation), regardless of the nature of the stimuli in the display. Local control factors, in contrast, are due to the relative salience of individual stimuli, and they determine the likelihood that attention will shift to a particular area in the display from the current fixation point. This study has emphasized global factors.

Global control factors typically derive from inter-individual differences, and are usually not directly influenced by marketers. They are nonetheless important, because they allow evaluating the robustness of the effect of manageable attentional determinants across common decision situations. In addition, sometimes marketers *can* influence global control mechanisms. For example, store atmospherics may be able to influence the mood or arousal level of consumers, which in turn may have subtle and probably unconscious influences on how they typically scan a choice display.

Still, manageable determinants of attention are frequently at the level of local control. Marketer' interventions influence the salience of individual brands in the choice display, and with it the extent to which individual brands or shelf locations attract consumer attention. In this study we did not experimentally induce such interventions, but allowed for natural variation in attention drawing properties of brand packages. Marketers can influence salience through attractive display or package design, but also through their influence on consumer familiarity with brand names, brand logos and a brand's visual appearance. Local control can also be more strategic, such as when consumers actively search for attribute information that would help them optimize their choice with respect to their purchase and usage objectives. Past research in decision making has been limited to these more strategic control mechanisms induced by cost-benefit considerations (Hauser and Wernerfelt, 1990) or usage goals (Ratneshwar and Shocker, 1991). Eye movement registration has the advantage that it can also capture global and local attentional determinants that are less strategic.

The present methodology offers important opportunities for managerial research on packaging and shelf layouts. In pre-testing packaging, the attention-grabbing power of the brand name, ingredient information, pictorial and other package cues could be examined, and their ability to retain attention under various environmental and consumer conditions could be studied. Similarly, various shelf-layouts could be studied for their effectiveness in drawing and keeping attention, and in distributing attention across brands in a desired way (see also Janiszewski, 1998). The effectiveness of various positions of brands relative to each other could be examined. This might answer questions about the optimal organization of shelf layouts, about whether and when store brands gain from being physically close to the leading brand, and about whether brands are better off providing ingredient information in the pictorials instead of in the text. Much more can be learned from the way consumers scan their environment for relevant information to make the choices that marketers are ultimately interested in.

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