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Understanding consumers' in-store visual perception: The influence of package design features on visual attention

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ABSTRACT

It is widely accepted that the human brain has limited capacity for perceptual stimuli and consumers' visual attention, when searching for a particular product or brain in a grocery store, should then be limited by the boundaries of their own perceptual capacity. In this exploratory study, we examine the relationship between abundant in-store stimuli and limited human perceptual capacity. Specifically, we test the influence of package design features on visual attention. Data was collected through two eye-tracking experiments, one in a grocery store using wireless eye-tracking equipment, and another in a lab setting. Findings show that consumers have fragmented visual attention during grocery shopping, and that their visual attention is simultaneously influenced and disrupted by the shelf display. Physical design features such as shape and contrast dominate the initial phase of searching. Time pressure and familiarity with the grocery store are studied and discussed.

1. Introduction

Purchase situations in the real world are characterized by multiple visual stimuli, buying decisions far from fully conscious, and only few stimuli make traces in the memory (Simonson, 1990). While the visual stimuli in advertising have been the subject for considerable research (e.g. Rossiter and Percy, 1987) the effects of visual cues on in-store decision-making are not thoroughly explored in marketing research. The Petty et al. (1983) well-known model on central vs. peripheral perceptions of marketing information describes the perceiver's response to the overall content of the message and neglects the individual visual cues. Also, basic marketing communication textbooks (e.g. Pickton and Broderick, 2005) assume visual cues to influence decision making, but treat them in general terms as product attributes. There is little research in the field of in-store visual attention influenced by design elements like brand cues, illustrations, and claims. Especially, research is missing when it comes to fast moving consumer goods (FMCG) and their appearance in grocery stores.

Today's supermarkets have plenty of products in the same category from different manufacturers and with nearly the same attributes. Too many products and too much information, in combination with a limited cognitive capacity (Miller, 1956), result in confused and less satisfied consumers (Schwartz, 2004). This discrepancy between too many stimuli and too little brain capacity makes it necessary to focus on what captures consumers' in-store attention. This article asks when and which visual elements on the package influence the in-store purchase decision.

In the next section the existing body of knowledge on in-store behavior in relation to visual attention is reviewed followed by a section exploring in-store behavior and cognitive capacity. In this section we also argue for hypotheses linking decision-making to visual perception. Section 4 describes the methodology and the research design, and our findings are presented in Section 5. Finally, the contribution to decision making in-store and the implication on further research is discussed.

2. In-store behavior and visual attention

Consumers make use of simple visual elements with limited cognitive effort to make fast FMCG decisions. Rather than long explorations, deliberations and acts of choice, consumers are more likely to reach their decisions within a few seconds (e.g., Hoyer, 1984; Dickson and Sawyer, 1990; Shiv and Fedorikhin, 1999). Pieters and Warlop (1999) found time pressure to influence visual

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attention and changing consumer preferences form emotional loaded design elements towards more rational packaging information. It illustrates how consumers skip certain design elements in order to optimize their decision process.

Conventional decision models for fast and often repeated purchases like *cue utilization model* (Olson and Jacoby, 1972) and *theory of planned behavior* (Ajzen, 1991) assume that consumers know what they come for, and that they will recognize products and brands when they see them. According to these models, consumers might formulate a set of personal criteria, explore several options, evaluate them, and then select the best among alternatives. These models do not explore how the visual field influences the decision. However, Ruth and Carol (2000) found a majority of British consumers (70%) not to have a complete overview of their purchase intentions when they enter the grocery store. In Urbany et al.'s (1996) study on pricing, 85% of consumers made a decision without picking up any alternative item, and 90% made a purchase after only having examined the front of the product. People simply choose with their eyes and purchase products they see. They become inspired, influenced, or persuaded by what they see, reflected in very large sales effects from, for example, special displays (Nordfält, 2011).

The need for knowing what consumers focus on, in combination with the necessity for getting their visual attention at the point of purchase, has been a long-time driver in marketing research. Review of the eye-movement literature reveals that people are not cognitively aware of what their eyes fixate on (Theeuwes et al., 1998). In a study by Chandon et al. (2009), consumers' visual attention and evaluation of supermarket shelves were examined. It revealed how in-store factors primarily influence visual attention, whereas external factors such as shopping goal and brand awareness influence evaluations better and are not mediated by in-store attention. It underlines how verbal recall of a decision making might be biased by, for example, brand elements taken from memory, and by that it becomes less useful for measuring visual attention.

By using planograms as stimuli Chandon et al. (2009) found a strong impact on visual attention from the number of facings but they did not differentiate on specific package design features, such as shape, illustration, color, etc. Van et al. (2008) found in-store stimuli like color, luminance and edges to be the main reason for brand salience effect, whereas out-of-store marketing activities such as advertising has less pervasive effect on search performance. The study also revealed consumers only using one or two visual features trying to locate a brand fast and accurately. Even though consumers combine several visual features for optimizing the search process, it has only a random effect (Reutskaja et al., 2011) and they optimize better by making up their own stopping rules.

It may well be that consumers are inspired, confused, or even disturbed by what they see on the shelf, but if consumers on the other hand do not discover the product on the shelf, the decision process cannot even start. It underlines the importance in getting visual attention and addresses the question why particular design elements capture the shopper's attention.

3. In-store decisions and cognitive capacity

The brand literature describes well designed and well known visual features like product name, logo/symbol, typography, and slogan as anchors in people's mind (Keller, 1993, 2003; Underwood and Klein, 2002). On the other hand, cognitive science tells us that objects people see regularly will get less visual attention over time or even be ignored (Rosbergen et al., 1995). New visual cues on product packages create impression of novelty and increase the cognitive work (Sherwood, 1999). Yet, new package design might also be seen as too strange ending up by being ignored (Schoormans and Robben, 1997) which ultimately becomes an economic loss (Lee et al., 2010).

Contrary to what rational choice models predict, consumers look too short and decide too fast in order to make a full-informed decision. Miller (1956) suggests that a person can cognitively process seven plus/minus two items at a time. Later, Cowan (2000) reviewed much of the research on this issue, and identified what was called *the magical number four*, still assuming a fixed cognitive capacity. Alvarez and Franconeri (2007) argued that the capacity was in fact flexible depending on the allocated resources, the noise and dynamics of the situation. This means that while a shopper moves around in-store, it limits the cognitive capacity to few objects and the ability to explore several products on the shelf is reduced.

In cognitive neuropsychology, visual attention is described in terms of the distinction between *orientation-attention* and *discover-attention* (Posner et al., 1980). Orientation-attention is a parallel sub-conscious (low-level) and unselective pre-attentive search process. It works fast and enables lots of input to be processed simultaneously. In a grocery store, it would allow consumers to get an overview of the range of products in a certain category. In consumer research, *orientation-attention* refers to a situation in which consumers search the shelf for a specific product, while perceiving several product designs in the beginning. Discover-attention refers to the deciphering of a particular object like exploring details on the packaging, reading technical details or warnings. In this case the consumer shifts to the slow serial search process and perceive one unit of information at a time.

Perkins (2002) describes the initial attention phase as undermanaged and controlled by low-level orientation processes. In the following process high-level vision is needed for a full perception of any object. In real world conditions, we cannot easily discriminate between these two perceptual systems (Duncan and Humphreys, 1989), and it seems likely that in a shopping situation both systems are activated. According to Pashler (1998), people seem to use the fast effective search system when it is easy to discriminate objects by their visual features. He found that people perform better when they discriminate between simple physical features than when they use semantic features, meaning rationally and informational loaded features. A strong visual cue may allow a company to gain a competitive edge in the search process.

Summing up, the literature indicates visual stimuli to influence the decision process, yet being less specific on when and which visual elements affect the choice. Nor does the literature indicate the types of visual features that may work. Physical features such as *contrast* and *shape* have been found to have a strong effect on visual attention (Theeuwes and Kooi, 1994; Theeuwes et al., 1998) and a combination of physical features does even have a stronger effect. As every object has a shape and every product on a shelf stands against the background with certain level of contrast, it indicates that products with a characteristic shape and with high level of contrast might facilitate consumers' initial visual attention better than those without. This gives the first hypothesis, whereas the discussion on how we measure characteristic shape and high level of contrast is taken later in the section on research design.

H1. Physical design features facilitate consumer's initial attention.

From the concept of *perceptual fluency* (Reber et al., 2004) we know that the visual stimulus implies both speed of reception and evaluation. In plain words it tells us, as long as the visual input fits an overall perception, the process runs fast and smoothly, and the

less time people have to use for getting the meaning, more positively will it be evaluated and more attractive will it be considered. The effect is the strongest when people are less cognitively involved, and for an in-store decision process, simple and limited design features on the packaging might give similar effect. Consumers might even prefer looking at products that are easier to interpret, and this brings us to our next hypothesis:

H2. Limited numbers of design features facilitate consumers' initial attention.

Wolfe (1994, 1998) takes the diversion of visual features one step further, and defines essential groups of basic visual features in his *guided search theory*. He distinguished between two groups of features that either facilitate a bottom-up process (affected by the stimuli itself) and features that stimulate a top-down process (controlled by the mind). Shape, contrast, size and orientation (angled or curved objects) are typically basic visual features that affect bottom-up attention, whereas text and semantic loaded features like brand color are basic visual features that typically relate to a top-down process. Wolfe acknowledges that in real world conditions, it can be difficult to distinguish clearly between the two types of processes facilitated by a certain feature, and sees the theory as a guideline for research. Table 1 illustrates how the two groups of basic visual features can be used for exploring features on packaging design.

Any bottom-up feature overrules a top-down controlled search strategy and no matter what, these visual features have the ability to capture attention (Whittlesea and Williams, 2000; Franconeri et al., 2004). That is, basic visual features in the category of bottom-up serve both as a facilitator of an easy and fast search process (Perkins, 2002) and at the same time these features become visual distracter (Hoffman, 1998; Yantis, 1998). In an in-store situation, packages with bottom-up features would be expected to get spontaneous attention, even though a consumer uses a top-down controlled search for a specific product. This leads us to the next hypothesis:

H3. Features facilitating consumer's initial attention also facilitate further attention.

As mentioned earlier consumers only spend few seconds making up their mind and time pressure forces customers to either rush through the information process delimiting the amount of information (Fasolo et al., 2009), or they change the search strategy weighting semantic package features over brand related design features (Pieters and Warlop, 1999). This leads us to the assumption that a consumer shopping under time pressure may shorten the search process paying attention to fewer products. At the same time the consumer may change the search strategy looking for design features with higher information value, meaning features that are characterized as those stimulating a top-down process. This brings us to the following hypotheses:

Table 1

Perceptual process of packaging features	Features stimulating a bottom–up process	Features stimulating a top–down process
Packaging design elements	Contour/shape Contrast Size Ratio	Brand letters Brand pictures Text and editorial elements Brand color

H4. Consumers shopping under time pressure pay attention to fewer products, compared to consumers not shopping under time pressure.

H5. Consumers shopping under time pressure pay attention to brand and text features, compared to consumers not shopping under time pressure.

Familiarity facilitates recognition, so a well-known brand is easier to identify and previous experience with the shop does also reduce the need for searching. Consumers will need less time making a decision when they purchase a well-known product and they will skip a thorough search process reducing the search time in front of the shelf. The same effect might be seen in relation to familiarity with the particular grocery store, leading to our final two hypotheses:

H6. Familiarity with the product category reduces the visual search time.

H7. Previous experience with the outlet reduces the visual search time.

4. Research design

Some studies of consumer behavior suggest that a minimum amount of visual attention is required for minimum responsiveness (e.g., Obermiller, 1985; Tsal, 1985; Cohen et al. 2012), whereas others state that consumers are able to receive, process, and store information even in the absence of attention (e.g., Zajonc and Markus, 1985). This contradiction might stem from the fact that people in the preliminary phase of a visual search process only analyze visual stimuli up to a certain conscious level, and therefore have no long-term memory for sorted out stimuli (Simons and Chabris, 1999; Simons, 2000). People dismiss stimuli they do not find relevant for their actual search, leaving no retrievable information. In the in-store situation consumers will have no memory for those products that only got initial attention, and research based on memory using interview or questionnaires are in our situation less useful.

Much current research on consumer perception is based on laboratory settings where people look at computer screens (e.g. Reimann et al., 2010). Brain scanning and eye-track research as well have mostly been performed in laboratories, with reduced external validity as a consequence. Real world behavior takes place in dynamic settings while people moving on their feet making an impact on perceived stimuli (Ingold, 2004). Portable and wireless eye-track system enables real time recording and allows participants to move around as they please. This equipment was used in-store to collect eye-movement data from a real shoppers search process.

The in-store eye-track experiment was conducted in a real grocery store using a SMI-iView X^{TM} HED-eye-tracker. Two lightweight cameras mounted on a bicycle-helmet record both eye movements and the scene in focus. This portable eye-tracking equipment recorded sequences with 25 pictures per second, revealing the exact position of the eye every 40 ms. Video recording of the participant's sight field and the eye-track recording started when the participant entered the store and continued until his/her arrival at the checkout desk.

In order to obtain a demographic variety in the sample the snowball method was applied for selecting participants, starting with the immediate network of colleagues and students. The sample consisted of 61 participants ranging in age from 20 to 63, 36 of whom were females. All participants volunteered and were prior to the test informed about the research setup, the functionality of the eye-track equipment, and data would be used for

scientific purposes. Participants were asked to do a normal purchase matching their daily needs, and therefore they were told not to do any shopping on the same day or on the day before the experiment in order to facilitate their authentic needs for daily goods. The participants were free to buy whatever they wanted, and they all paid for their own purchases. They were given no time limit.

Following the check out, the participants answered a short questionnaire about personal cues, shopping habits, the particular purchased products, and whether they have had a feeling of time pressure.

The particular store and the jam category were chosen as objects for the experiment prior to the test. The reason given was that jam is an ordinary product commonly used in many families, and the jam category in the actual supermarket contained 95 different forms in terms of flavor, size, and brand. The product displays (placement of packaging on the shelf) was not manipulated in any way and there was no separate advertisement or offer for the products related to this category in the period of the survey.

The eye-tracking videos of those participants who searched for a product in the jam category were taken out for further analysis, reducing the number of participants from 61 to 47 ($N=47$). These videos were analyzed frame by frame, coding gaze time and number of fixations. The minimum numbers of video frames required to code as one fixation were three (120 ms), because human fixation duration has a range from 150 ms to 600 ms (Duchowski, 2003). These data were related to (1) participant's initial attention, meaning the first eye contact on a particular product and (2) participant's further attention, meaning following gaze time on the product. This provided us with data on gaze time and number of fixations on each of the 95 jam product from the very first eye contact until physical contact with a certain product. These data were taken into an Excel sheet.

The next step was a classification of each product in the jam category in order to get data on design features and categorize these features into contrast, shape, brand feature, etc. Several options were available, for example, simple counting or asking people. For some vivid design features that stand out it might be an easy task, but for more sophisticated smaller features it might result in ambiguous response. As people perceive their surroundings as a whole asking them makes it difficult to determine whether a specific design feature should be counted as a separate one or part of a group.

As this classification deals with visual perception we set up a second eye-track experiment in a lab setting using a SMI-iView X^{TM} RED-eye-tracker. In this experiment another group of test persons ($N=11$) saw exactly the same jam products as found on the shelves in the grocery store. Participants were randomly sampled similar to the store experiment. They were told to examine a range of ordinary jam products from an ordinary supermarket, and they were supposed to search for particular design features they found interesting. They were informed that there would be no questionnaire afterwards in order not to influence their immediate visual attention (Yarbus, 1967). Each picture of a jam product was shown in a fixed time of five seconds.

There are several ways of analyzing data from this second eye-track survey and we used the dispersion-threshold identification method (Salvucci and Anderson, 2001). Using the SMI BeGaze-software with a dispersion setting on 100° and a duration setting on 100 ms the eye-position and total gaze-time are then calculated for each jam product. Areas with more than 5% of the total gaze time were defined as a design feature of interest and areas with less than 5% of the gaze time were ignored. This gave us the number of design features for each product in the particular jam category, which was further sub-categorized in relation to the list of features, mentioned in Table 1. The total gaze time for each design feature was used as weight for the specific element. In order to get data on contrast, we used the *value/lightness* dimension from the Munsell color system, calculating the value pixel by pixel in the digital picture of the products, giving us a "*blurring value*" for each product in the category. A high contrast value reveals a difference between high and low luminance meaning a sharp edge between areas of black and white pixels.

The ratio is determined by simple measurement and calculating relation between length and height. This gave a deviation of the jam packaging where 56% was categorized as *square* and 44% categorized as *high slim*. For each product in the jam category we now had a feature classification, and these data were taken into the Excel-sheet together with in-store eye-track data for statistical analysis.

5. Findings

The in-store experiment ran in real life condition, and in order to reduce the influence from sold out products or an over-representation of one specific brand, groups of jam products with only one item on the shelf and groups with more than four items on the shelf were excluded from the analysis. Remaining groups of products made 83% of the jam category in the grocery store.

On average, participants gazed at 36 out of 95 jam products. That is, a little more than one third of the category received initial visual attention. Not surprisingly there was a correlation between the number of products that received initial attention and the total time a participant spent in front of the products (B: 0.022; $p < 0.001$). That is, the more time a consumer uses in front of the category the more products will get visual attention.

A regression analysis was conducted to find a relation between initial attention and design features. We found the design feature *contour/shape* having the ability to attract consumers' initial visual attention (B: 0.883; $p < 0.0001$). Looking into the detail of the contour/shape feature (dividing width by height), we found high slim product draw consumers' initial attention better (B: -0.408; $p < 0.03$). Using the *blurring value* for each product, we also found design features that stand out to have higher likelihood getting consumers' visual attention, meaning features with high contrast facilitate initial attention (B: -0.695; $p < 0.001$). The design feature categorized as text element had a negative influence on consumers' initial attention (B: -0.433; $p < 0.024$). We conclude that consumers' first eye contact depends on simple physical design features, meaning features with little semantic content facilitates initial attention. This verifies our first hypothesis.

The regression analysis did not find a significant relation for design features like size, typography, brand letters, brand pictures, and color. We found that products with fewer design features have higher likelihood for getting initial attention (B: 0.777; $p < 0.0001$), meaning graphic design easy to interpret also facilitate initial attention verifying our second hypothesis.

The situation after the first visual attention is a matter of maintaining and facilitating the information process. On average consumers pay attention to less than 14 jam products in this phase of the decision process. It is nearly half of those products that got the first visual attention. In other words, only half of the products in the category get more than one eye contact. A regression analysis found a stronger effect in this phase from products ratio (B: $-13{,}551$; $p < 0.001$) meaning high slim products also facilitate consumers' further attention. We did not find significant relations between other design features and consumers' further attention. The average gaze-time on each design feature (0.46 s.) has barely increased in this phase compared to gaze-time in the preliminary phase (0.35 s.), indicating a similarity in these two phases. This partly verifies our third hypothesis.

In the post-purchase questionnaire, consumers were asked whether they have experienced time pressure. Consumers, who explicitly expressed an experience of time pressure made a group on nearly 50% and these consumers in fact, spent more time in front of the product category than those who did not, meaning average time at the product category for this group was above 44 s. It did not correlate with short and fast purchase decisions and either there was a correlation between these participants' pattern of eye movement, their search for specific product information or search for design features easy to perceive. This rejects hypotheses 4 and 5.

In the post-purchase questionnaire, consumers were asked whether they have previous experiences with the product category and the particular brand they had purchased. We found no correlation between consumers' visual search patterns and their previous experiences, neither to their familiarity with the product category or the particular brand. This rejects hypothesis 6.

In the post-purchase questionnaire, consumers were asked whether they have previous experiences with the particular grocery store. Consumers' familiarity with the store decreased gaze time for initial attention ($B: -1.477$; $p < 0.026$) as well as further attention phases ($B: -11.223$; $p < 0.001$), meaning previous experience with the outlet reduces the visual search time. This verifies hypothesis 7.

6. Conclusion and discussion

Package design features stimulating a bottom-up process facilitate the early visual process and by that it facilitates the start of the in-store search process. Design features like contour/shape, contrast, and ratio have this advantage and design features with semantic content like text-elements are not suitable for getting consumer's first eye-contact in-store. In fact less than half of the jam product category got visual attention, showing that getting initial attention is essential for being considered as a potential purchase. Making use of design features stimulating a bottom-up process might even reduce the risk of being overlooked on the shelf.

Making use of these features is one way of getting consumers' visual attention, another is to reduce the number of features. Products with few design features did actually have the ability to attract consumers' first attention. We then see two ways of getting the information search process started, by either using features stimulation by the bottom-up process or making simple package design that is easy to interpret.

Participants' eye-movements might be seen as casual attention and interpreted as indecisive behavior. In fact participants were distracted by other jam jars on the shelf, which also had a design that stimulated the bottom-up process and which are able to disrupt consumers' visual search. Consumers' eyes drifted around and visual attention had to be re-established again and again. In our in-store experiment we only found this effect significant for tall and slim products, underlining the influence from other package design features like text-elements and brand-elements in persisting visual search process.

We expected consumers to have a more clear and determined decision process when they were on a hurry. In this study we did not find such evidence. On the contrary, we found consumers to use more time under time pressure, which actually contradicts general assumption and findings in marketing studies. Our finding might stem from the fact that participants assessed their own time pressure after the purchase, and using lot of time in front of the category might lead to a feeling of wasting time and being late. Participants who on the other hand rush through the product category making fast decisions do not get the annoying feeling of wasting time, even though they might be seen as doing their purchase under limited time.

For participants familiar with the purchased brand, we did not find any significant pattern of eye-movements. At least it did not shorten the process. On the other hand, brand elements were not found as significant visual features to influence the later decision process or being the final visual clue in the persuasion. This underlines the challenge in interpreting eye-data, as the gaze-time on a brand element might even be very short but with a large mental effect, since brand elements are highly semantic loaded visual elements.

Familiarity with the store decreased the time participants used in front of the category, which is in line with general knowledge on visual attention. When we become familiar with something, whether it is a supermarket, interior design at our office, or a painting on the wall we pay less attention to these items. As for product brands that need re-design, store layout has to be re-designed for making consumers stay longer in front of the category.

7. Direction for further research

This study did not reveal a significant relationship between participants' eye-movements in-store and high-level design features. This, of course, does not mean that we ignore the possibility that these design features may play an important role in later stages of the decision process. Even though consumers needed semantic design features to guide their decision in later phases, we found that they had short fixations and gaze patterns similar to those found in the preliminary phase. Similar to the initial attention phase visual attention in the following phase was characterized by a muddled search pattern, supporting the idea, that the switch between low order affective processes and high order cognitive processes is undermanaged and influenced by visual features in our surroundings (Perkins, 2002). This visual attention perspective challenges the assumption that consumers are driven by deeper needs, and their moves focus towards those visual cues. This view on decision-making is also found in the idea that human beings are thrown into the world and must act on the spot, rather than plan ahead (Clark, 2003).

One implication of this study for graphic designers dealing with packaging design is that brand features are not what start the in-store communication process. On one hand, consumers need these higher-level design features like text-elements, brand labels, or brand color in order to fully understand the product, which are being overlooked as a consequence of the lack of low-level design features. A taxonomy of design features adjusted for a specific product category may be helpful, finding the balance between simplicity and sophisticated package design. Further research for getting a better framework for designing FMCGs is needed. It should also be mentioned that findings in this study relate to the *size* of packages we normally find in the jam category. Interpretation of odd size packaging might be characterized by other design features and search processes.

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