Journal of Consumer Behaviour
J. Consumer Behav. **7**: 342–359 (2008)
Published online in Wiley InterScience
(www.interscience.wiley.com) **DOI:** 10.1002/cb.256

What they see is what they get? An fMRI-study on neural correlates of attractive packaging

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- *There is evidence in neuroscience that the brain processes negative visual stimuli in a different manner than positive ones. Our study investigates, whether it is possible to transfer these findings to one specific, often-neglected marketing stimulus, package design. For this purpose, we measured the brain activity of subjects while they had to make decisions about the attractiveness of certain fast moving consumer good packages. As predicted by consumer neuroscience, we found that attractive and unattractive packages are able to trigger different cortical activity changes. Contrasting attractive versus unattractive packages, revealed significant cortical activity changes in visual areas of the occipital lobe and the precuneus – regions associated with the processing of visual stimuli and attention. On the individual level, we found significant activity changes within regions of reward processing. On the other hand by contrasting unattractive versus attractive packages we found an increased activity in areas of the frontal lobe and insula cortex, regions often associated with processing aversive stimuli such as unfair offers or disgusting pictures. Although, these results are without any doubt preliminary they might explain why attractive packages gain more attention at the point-of-sale and this, in turn, positively influences turnovers of fast moving consumer goods.*

Introduction

Research in consumer behavior has always been influenced by the integration of other scientific disciplines, such as mathematics, sociology, and perhaps in the first place, psychology. Recent years have seen the development of a new integrative discipline which can be labeled as ''neuromarketing'' or ''consumer neuroscience.'' The goal of this emerging discipline is the transfer of insights from neurology to research in consumer behavior by applying neuroscientific methods (i.e., neuroimaging techniques, such as functional magnetic imaging (fMRI)) to marketing relevant problems. Current studies in the field of consumer neuroscience are connected with structural marketing topics, such as buying

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Note: All figures will be produced in colour in the online published version.

behavior (Knutson *et al.*, 2007), branding (McClure *et al.*, 2004; Deppe *et al.*, 2005b; Yoon *et al.*, 2006) or advertising (Klucharev *et al.*, 2005). One major finding of these studies is the high level impact of emotions and affect on customers' decision-making processes. For instance, the study of Deppe *et al.* (2005b) showed that strong brands trigger emotions that influence decision-making. In a similar vain McClure *et al.* (2004) and Plassmann *et al.* (2007) demonstrated that the brain activity and the expressed preferences may change when consumers are exposed to brand information. Moreover, the investigations of Plassmann *et al.* (2007) revealed that customer loyalty is associated with activity changes in the (neural) reward system. In a recent, groundbreaking study, Knutson *et al.* (2007) reported that the activation of the nucleus accumbens (NCC) seems to scale with product preferences of a consumer, and that excessive prices can lead to an activation in the insular cortex (perception of losses) and to a deactivation in the medial prefrontal cortex (MPFC) prior to the purchase decision.

The present article can be integrated in the branch of consumer neuroscience as well, because it investigates the neural correlates of product packages as marketing stimuli. Starting point of this study is the assumption that looking at different packages can lead to diverse levels of attention and cortical activation pattern, depending on the package's attractiveness. Our presumption is based on recent evidence derived from marketing research and neuroscience; different (visual) stimuli are able to trigger varying levels of attention (Aharon *et al.*, 2001; Segerstrom, 2001; Smith *et al.*, 2003) and visual attention might have a significant influence on preferences (Shimojo *et al.*, 2003) and brand choice (Pieters and Warlop, 1999).

We call this research to be relevant for marketing and consumer research, because the relationship between visual processing and packaging still suffers from lacking theory, even though the product package is one of the most relevant marketing instruments for fast moving consumer goods at the point of sale (Silayoi and Speece, 2004). For example, two-thirds of all supermarket purchase decisions have been reported to occur when the consumers are actually in the store (Schoormans and Robben, 1997). At this stage, the product as packaged can influence the purchase decision to a high degree. That is why firms often spend more money on packaging than on advertising (Schoormans and Robben, 1997).

Because of the great effort companies go through to optimize the product design, the question arises whether attractive packages are able to yield different brain activations than unattractive or neutral ones. Taking into account that the brain can be considered as the organ of decision-making the answer to this question might be substantial for marketing theory and practice.

Conceptual framework

Packages in marketing research

In order to survive against their competitors, companies often invest large amounts of money in product differentiation. Nevertheless, empirical studies show that the perception of distinguished products is decreasing on a long-term basis. For example, two-thirds of German customers stated that they do not see any difference between one brand and its competitors (http://www.bbdoconsulting.com, 2007). Therefore, it is very important for marketers to understand the effect of various product differentiation strategies such as packaging, in order to employ them in a more effective way. Because of its great impact on the perception of a brand, packaging is sometimes even called the ''fifth P'' (Kotler and Keller, 2006; Nickels and Jolson, 1976). In general, product packaging comprises ''all the activities of designing and producing the container for a product'' (Kotler and Keller, 2006, p. 393) and fulfills three main functions: the protection of its content, the supply of information and the distinction of a product from other brands by attracting the attention of the consumer.

Traditional consumer research mainly emphasized on the external cues (McDaniel

DOI: 10.1002/cb

and Baker, 1977; Wansink and van Ittersum, 2003) of product packaging such as weight, height, shape (Rhaghubir and Greenleaf, 2006) size (Wansink, 1996) or multiple packaging (Dempsey, 1959). Less attention was paid to psychological or communicative effects such as product imagery (Underwood *et al*., 2001) or design (Bloch, 1995; Schoormans and Robben, 1997) that may have an important influence on the decision-making of customers. According to results of Bloch (1995), who investigated and modeled relations between the design of a product and a consumer's psychological and behavioral responses, we explicitly concentrated on the attractiveness aspects of product packages.

Packages in the brain

To the best knowledge of the authors, there exists no study that investigates the neural correlates of packaging perception. Rather, drawing parallels to other findings from consumer neuroscience can yield assumptions about how attractive packages may stimulate specific brain areas in a different way compared to unattractive ones. For example, we can revert to various studies that explore different cortical activation pattern of advertisement and face or object perception and evaluation. In particular, we will refer to studies that examine attractive versus unattractive and positive versus negative stimuli.

Ambler *et al*. (2000) were one of the first who explored explicit differences between tasks containing different antagonistic visual stimuli, by investigating the effect of emotionally engaging ads versus reasoning-engaging ads. Their results showed strong positive correlations between affective ads, memory and reward related brain activity. It might far fetched to compare attractive level of packages with different emotional types of advertisement, but there are two reasons why we want to include Ambler *et al*. (2000) in our argumentation. First, there is evidence that attractive packages might act as affective stimuli as well and are therefore perceived similar to emotionally engaging ads (Schoormans and Robben, 1997; Barnes *et al*., 2003; Kotler and Keller, 2006). Secondly, Ambler *et al*. (2000) provided evidence that the brain processes varying visual stimuli differently. This finding constitutes the basis of the present study, which investigates cortical activity changes for attractive versus unattractive stimuli. Another study conducted by Kenning *et al*. (2007b) address the issue of the impact of attractive versus unattractive ads on the perception of advertising. The results showed that ad attractiveness modulates activations in the fusiform face area, high order visual cortices, posterior cingulate cortex, nucleus accumbens, and MPFC.

Closer related to the exploration of how the brain processes different visual stimuli are studies conducted by Erk *et al*. (2002) and Aharon *et al*. (2001) that investigate object and face perception in the brain. For example, Erk *et al*. (2002) found increased activities in visual areas of the occipital lobe and regions related to reward processing while subjects evaluated ''preferred'' objects (sports cars) versus ''not-preferred'' objects (small cars). Analog, Aharon *et al*. (2001) found cortical activity changes in reward related brain areas, when their male participants evaluated pictures of beautiful male and female faces as well as by passively looking at pictures of attractive female faces.

The present study investigates the assumption that only products that attract the attention of a consumer at the point of sale are able to play a dominant role in his purchase decision-making process (Bloch, 1995; Underwood *et al*., 2001; Silayoi and Speece, 2004). Other functions, such as information about the content, the protection and the intended purpose of a package might only play a secondary role. Therefore, we observe if evaluating and looking at attractive packages lead to different brain activity in comparison to neutral or unattractive packages. Particularly, we want to focus on the question whether attractive packages yield stronger activity in brain structures that drive attention and memorization (Kastner and Ungerleider, 2000) as well as object processing (Erk *et al*., 2002; Grill-Spector, 2003; Kenning *et al*., 2007b) in contrast

DOI: 10.1002/cb

to neutral and unattractive packages. Moreover, it will be interesting to investigate if the evaluation of attractive packages is associated with reward related regions in the brain (O'Doherty, 2004) analog to studies regarding object and face perception and evaluation (Aharon *et al*., 2001; Erk *et al*., 2002; Deppe *et al*., 2005b).

Against this background we hypothesize as follows:

> **H.** *Attractive packages will trigger different brain activity than unattractive packages. While the evaluation of attractive packages is represented by activity changes within cortical areas that are associated with visual attention and reward, the evaluation of unattractive packages is accompanied with increased activity in brain areas associated with the processing of aversive stimuli.*

In order to test this hypothesis, we conducted a functional magnetic resonance imaging (''fMRI'')-experiment. We used fMRI because it allows us to measure neural activation (a) in a non-invasive way, (b) with acceptable temporal and spatial resolution (Poels and Dewitte, 2006), and (c) in the whole brain, including the cerebellum.

Technology and methodology

Pretests

In a first behavioral study, we investigated related to theories in marketing research (Schoormans and Robben, 1997) whether the product package is an important attribute for consumer decision-making. In a two-stage experiment similar to anonymous taste tests of Coke versus Pepsi (de Chernatony and McDonald, 1998) we were able to show that the variation of packages (e.g., changing a Nivea can from blue to red) led to preference reversals. Accordingly, we conclude that packages do have an influence on consumer preferences (for details see: Berentzen and Ommen, 2007). Following the results of this first behavioral study, we conducted a two-stage pretest in order to extract packages that show significant different behavioral results regarding the attractiveness evaluation.

In the first stage of the pretest, 131 packages from current range of goods of well-known German supermarkets (food and non-food categories) were evaluated from 6 subjects on a score ranging from 1 = very unattractive to 10 = very attractive (Walker and Dubitsky 1994). Next, we calculated the mean and the standard deviation of each package. The three first exclusion criteria were: (1) a standard deviation higher than 2, (2) the same means, and (3) the same product. The aim was to get homogeneity between products with a similar attractiveness level and a strong heterogeneity between packages with a different attractiveness level.

For the second stage of the pretest, we used the 86 remaining original paper-based packages. To ensure that there is variance in attractiveness, the packages were rated by 51 randomly selected subjects (23 female, 28 male) on a score ranging from 1 = very unattractive to 10 = very attractive (Walker and Dubitsky 1994). According to Deppe *et al*. (2005a), and in order to sharpen contrast, we then classified the packages into three groups. Packages scored 6 or above on the scale were grouped into the + category, while packages with a score of more than 5 but less than 6 were grouped as neutral (Ochsner, 2001). Finally, packages with a score of 5 or less were classified as −. We then selected only the 10 most attractive (P^+), the 10 least attractive (P^-), and 10 neutral packages (P^0) for the neuroimaging experiment (Means: P^+: 7.08, P^0: 5.42, P^-: 3.13). An ANOVA confirmed the chosen packages as being significant different concerning the level of attractiveness ($F(2,27) = 264.271$, $p < 0.000$).

Main study: The fMRI experiment

Subjects

We chose four male and seven female, healthy, right-handed subjects to participate in the main

DOI: 10.1002/cb

study. To evade confounding effects due to age differences, (Phillips and Stanton, 2004) we selected only subjects from the young adult segment (18–26 years). Standard exclusion criteria for MR examinations were applied. Because we employed visual stimuli, subjects with strong myopia or other relevant constraints of vision were also excluded. All subjects provided written informed consent prior to the scanning sessions. The subjects were also informed that the examination could potentially reveal medically significant findings and were asked, if they would like to be notified in this case. An ethics commission has approved the study.

Experimental procedure and image presentation

During the scan session, a photo of a selected package from the pretest was projected into the visual field of the participants every 10 second (see **Figure 1**). The sequence of the images was pseudorandomized. Task of the volunteers was to judge whether a package is attractive or unattractive by pressing one of the two corresponding buttons on a magnetic resonance compatible response box. The responses were recorded with the use of specific software. In the forced-choice-task, subjects had to evaluate each of the selected packages four times (120 decisions) according to their attractiveness. In order to achieve a higher comparability with other studies within this special field of research (e.g., Deppe *et al.*, 2005a, 2007), we renounced rest periods during our evaluation task. Participants were advised to avoid head movements during the measurement. Head fixation was performed by foam pads and a soft headband. Earplugs were employed to protect against scanner noise and to allow for communication with the volunteer, for example, to announce the commencement of the decision task. Controlled by a personal computer in the MR control room, images were projected onto a screen fixed at the rear opening of the MR bore. A subject lying in the bore could view the screen via mirror. As the images covered about 50 per cent of the subject's whole field of view, even small details of the displayed packages could be recognized easily.

Within a fixed 5-minute period before the scan session, each participant had the possibility to examine visually and haptically the 30 packages presented on a table. The aim was to diminish possible individual familiarity differences between the packages. Furthermore, it was taken care to present the different packages equal in size, position, background, and luminance in order to prevent external confounding visual stimulation (Kenning *et al.*, 2007b). We consciously accepted confounders of visual stimulation like color, shape, or complexity of the packages, because aim of this study was the investigation of general differences in neural processing of packages with varying attractiveness levels.

Figure 1. Example of packages presented during the scan session (1) left: package P^+ and (2) right: package P^-.

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Data analysis

The study was executed on a 3T scanner (Magnetom Trio, SIEMENS, Erlangen, Germany). The protocol included a 3D isotropic T1-weighted data set of the whole head, with a measured voxelsize of 1.0 mm edge length for anatomical identification and coregistration into the Talairachspace. Functional images were acquired using a T2* weighted single-shot gradient echo-planar imaging (EPI) sequence, which covered nearly the whole brain. The data set consisted of 36 transversal slices of 3.6 mm thickness without a gap, FOV $230 \times 230\,mm^2$, acquired matrix 64×64, that is, isotropic voxels with 3.6 mm edge length. Contrast parameters were TR = 3000 msecond, TE = 50 msecond, flip angle = 90°. The stimuli were projected with a LCD beamer on a transparent screen and viewed from the other side via a 45° mirror mounted on an element phase array coil.

The presentation was triggered by the MR-scanner. All data were logged on a PC image processor. Statistical analyses were conducted with SPM5 (http://www.fil.ion.ucl.ac.uk/spm) (Friston *et al*., 1995; Friston, 1996). To correct for artifacts due to head movement all images were realigned to the first image of the session, normalized to the standard MNI-template, re-sampled to a common standard coordinate space (Ashburner *et al*., 1997), and smoothed with an 4-mm full-width-at-half-maximum Gaussian kernel. Activation was tested by convolving the vectors of onset with the SPM5 built-in hemodynamic response function, and using the ''general linear model.'' Onsets were constructed within a (3×40)-matrix including one vector for each attractive level (attractive, neutral, unattractive) and the in advance extracted packages according to P^+, P^0, and P^-. (see also results of the behavioral data). Realignment parameters were included as additional co-variates (Kenning *et al*., 2007b). For the group analysis, the contrast images for the conditions attractive versus unattractive packages and *vice versa* tasks were analyzed with a one-sample *t*-test (random effect analysis) using the *t*-contrast of the single subject analysis. Data analysis was applied according to Kenning *et al*. (2007a) and Poldrack *et al*. (2007).

Coordinate assignment

The obtained MNI (SPM5)-coordinates within the firm data analysis are not congruent with the coordinate system developed by Talairach and Tournoux. Therefore, all coordinates received by SPM5 were transformed to the Talairach and Tournoux space and assigned to cortical regions with the T2T-database Java applet (http://www.neuro03.uni-muenster.de/ger/t2tconv/) (Poldrack *et al*., 2007).

Behavioral analysis

After the scanning session, participants were requested to fill out a questionnaire containing complementary questions about the attitude toward the three main functions of packaging (protection, information, and attention attraction at the point of sale (Kotler and Keller, 2006). For the present study, we only want to focus on the individual attitude toward the function of attention attraction at the point of sale. The questions were scaled on a five-point Likert Scale with 1 = strongly disagree and 5 = strongly agree. The scales were pretested by 61 participants and revealed reliability with a Cronbachs' α of 0.832 (six items).

Next, we calculated individual attitude means (sum of the answers divided by number of items) in order to compare the individual attitude toward packages with the cortical activation pattern on a single subject level.

Results

Behavioral analysis

First, before stating the results of the fMRI-analysis, we had to verify our prescribed onset differentiation based on the separation of the pretest. This pre-step was necessary in order to both construct valid and reliable onsets for the contrast of attractive and unattractive packages and to justify our chosen onsets in

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the data analysis. As expected, we found that the behavioral data of the main study were congruent to those of our second pre-study. While packages from the P^+-group gained 87.95 per cent [1] positive judgements, the packages from the P-group only gained 24.32 per cent positive judgements. The score for the P^0-group was in between (63.18%). A following ANOVA-analysis confirmed this differences to be significant ($F(2,27) = 25.762$, $p < .001$). Therefore, we used the definition of our onsets within the first level analysis according to the three ex ante-classified groups (P^+, P^0, and P^-) (Kenning *et al.*, 2007b).

Secondly, according to the behavioral attitude task, we divided the participants into two groups. Group 1 contained subjects with a positive attitude toward packages (attitude mean > 3.21[2]) and group 2 consisted of subjects with a negative attitude toward packages (attitude mean < 3.21). An ANOVA revealed this separation to be significant ($F(1,9) = 13.72, p < 0.005$). A discrimant analysis showed that two of six questions significantly separate the two groups ($F_1(1,8) = 11.17, p < 0.01$; $F_2(1,8) = 5.25, p < 0.05$).

Especially the results of the ANOVA showed that there are significant behavioral differences between the participating subjects. The comparison of the behavioral results and the individual brain activity by contrasting attractive versus unattractive packages provided evidence that four out of five (subject number: 1, 2, 6, 11) participants with an attitude mean > 3.21 exhibited stronger cortical activation changes than participants with an attitude mean < 3.21 (subject number: 3, 4, 5, 8, 9, 10) (see **Table 1**).

FMRI-analysis

The single subject analysis of an exemplary chosen subject[3] revealed significant activations ($T = 4.25$, $p < 0.005$ (corrected (FDR)), extent threshold $k = 5$) within visual areas of the occipital lobe, medial prefrontal gyrus, orbitofrontal cortex, anterior cingulated, and posterior cingulate cortex (**Figure 2**).

The most interesting activity changes compared to the other participants, we observed in the left medial frontal cortex (MNI: $x = -10$, $y = 52$, $z = -4$, $T = 4.62$, $p < 0.001$, cluster size = 10), the right orbitofrontal cortex (MNI: $x = 4$, $y = 44$, $z = -20$, $T = 4.76$, $p < 0.001$, cluster size = 5), the right anterior cingulate (MNI: $x = -8$, $y = 36$, $z = -6$, $T = 4.98$, $p < 0.001$, cluster size = 17), and the right posterior cingulate (MNI: $x = 10$, $y = -50$, $z = 16$, $T = 5.35$, $p < 0.001$, cluster size = 73).

The remaining results of the other 10 subjects are displayed below (Table 1) and discussed later. This table contains the number of subjects, the cortical area, exemplary chosen srepresentative MNI coordinates, and the corresponding statistics of the most interesting peaks within the different brain areas.

The random effects group analysis of the functional imaging data revealed significantly increased activity ($p < 0.001$, (uncorrected), extent threshold $k = 5$) in visual areas of the occipital lobe and the precuneus (see **Figure 3**).

The most interesting cortical activity changes between attractive versus unattractive packages have been observed in areas of the right inferior occipital cortex (MNI: $x = 32$, $y = -90$, $z = -10$, $T = 6.83$, $p < 0.001$, cluster size = 23), the right middle occipital cortex (e.g., MNI: $x = 32$, $y = -96$, $z = 4$, $T = 6.91$, $p < 0.000$, cluster size = 30), the cuneus (MNI: $x = 6$, $y = -98$, $z = 16$, $T = 6.21$, $p < 0.001$, cluster size = 45) and the precuneus (MNI: $x = 36$, $y = -70$, $z = 40$, $T = 5.93$, $p < 0.001$, cluster size = 7).

In contrast, in the P^-P^+-condition we found significantly increased activity ($p < 0.001$, uncorrected, extent threshold $k = 5$) in regions of the left frontal lobe, especially in the medial and middle and superior frontal gyrus. Additional results were significant activities in the insula ($p < 0.005$, extent threshold $k = 5$). (see **Figure 4**).

[1] values = means.
[2] overall mean of the attitude task ($n = 11$).
[3] The subject showed significant activity changes within an analysis of strong statistical values.

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Table 1. Single subject analysis ($T = 3.11$, $p < 0.001$ (uncorrected), extent threshold $k = 5$)

Subject number	Contrast: attractive minus unattractive packages ($T = 3.11$; $p < 0.001$ (uncorrected), extent threshold $k = 5$) Cortical region		MNI (x, y, z)	Statistics (T; cluster size)	Contrast: unattractive minus anattractive packages ($T = 3.11$; $p < 0.001$ (uncorrected), extent threshold $k = 5$) Cortical region		MNI (x, y, z)	statistics (T; cluster size)
2	Precentral gyrus	L	−6, −46, 66	4.46; 56	Superior frontal gyrus	L	−28, 48, 26	5.34; 61
	Supramarginal gyrus	R	54, −52, 28	4.07; 78	Inferior frontal gyrus	L	−52, 16, −6	4.44; 52
	Cuneus	R	2, −96, 6	4.38; 57	Medial frontal gyrus	L	−6, 58, 24	4.03; 13
	Middle occipital gyrus	R	28, −100, 6	4.21; 22	Middle frontal gyrus	L	−48, 38, −2	3.77; 13
	Precuneus	R	6, −64, 28	3.85; 54	Lingual gyrus	R	12, −86, −4	4.17; 18
	Anterior cingulate	R	4, 46, −2	3.93; 59				
	Posterior cingulate	R	6, −44, 24	3.60; 7				
	Superior frontal gyrus	R	14, 60, 18	3.58; 16				
3	Middle occipital gyrus	R	30, −98, 12	7.62; 2793	Medial frontal gyrus	R	6, 48, 48	4.26; 21
	Lingual gyrus	L	−26, −86, −8	7.08; 1126	Superior frontal gyrus	R	20, 60, 20	4.01; 52
	Middle occipital gyrus	L	−40, −78, −16	3.91; 153	Superior temporal gyrus	R	50, −62, 28	4.13; 42
	Medial frontal gyrus	L	−14, 54, 0	3.81; 5	Precuneus			
	Superior frontal gyrus	R	24, 54, −4	3.53; 13	Fusiform gyrus	R	10, −60, 44	3.72; 25
	Fusiform gyrus	R	36, −38, −24	3.70; 37		R	56, −2, −28	3.29; 5
	Parahippocampal gyrus	L	−36, −22, −26	3.34; 5				
4	Middle occipital gyrus	R	30, −98, 18	3.97; 32	Middle frontal gyrus	L	−48, 46, −6	4.12; 80
	Middle frontal gyrus	R	46, 34, 38	3.43; 12	Precentral gyrus	L	−46, −8, 58	3.97; 24
					Inferior frontal gyrus	L	−50, 12, 30	3.57; 20
					Superior temporal gyrus	R	48, 6, −44	3.89; 12
					Inferior parietal gyrus	R	2, −50, 48	3.64; 23
					Middle occipital gyrus	L	−58, −66, −8	3.37; 6
5	Inferior occipital gyrus	R	32, −84, −12	7.09; 1532	Lingual gyrus	L	−10, −82, −8	4.13; 41
	Cuneus	L	−6, −98, −4	6.53; 95	Cuneus	R	8, −86, 6	3.73; 12
	Middle occipital gyrus	L	−26, −92, 18	5.51; 389	Inferior frontal gyrus	L	−40, 34, 2	3.74; 7
	Lingual gyrus	L	−24, −78, −14	4.93; 118	Superior frontal gyrus	L	−10, 56, 30	3.71; 7
	Fusiform gyrus (temp.)	L/R	−32, −44, −18	4.25; 26	Superior temporal gyrus	L	−64, −44, 4	3.69; 7
	Fusiform gyrus (occ.)	R	32, −60, −14	4.21; 70				

(*Continues*)

DOI: 10.1002/cb

Table 1. (Continued)

Subject number	Contrast: attractive minus unattractive packages ($T = 3.11$; $p < 0.001$ (uncorrected), extent threshold $k = 5$) Cortical region		MNI (x, y, z)	Statistics (T; cluster size)	Contrast: unattractive minus anattractive packages ($T = 3.11$; $p < 0.001$ (uncorrected), extent threshold $k = 5$) Cortical region		MNI (x, y, z)	statistics (T; cluster size)
6	Middle occipital gyrus	R	30, −94, 16	6.06; 147	Middle temporal gyrus	L	−50; −20; −18	4.03; 14
	Cuneus	R	14, −92, 26	5.83; 275	Medial frontal gyrus	L	−14, −22, −54	3.82; 5
	Inferior occipital gyrus	L	−34, −90, −6	5.27; 362	Inferior parietal lobule	L	−48, −48, 50	3.59; 9
	Middle occipital gyrus	R	26, −84, −14	5.37; 44	Caudate	L	−10, 12, −2	3.43; 5
	Fusiform gyrus	L	−26, −68, −14	3.66; 22				
	Middle temporal gyrus	R	46, −80, 16	4.19; 21				
7	No suprathreshold clusters				Middle occipital gyrus	L	−24, −100, 16	3.81; 9
					Precentral gyrus	R	52 0 52	5
8	Lingual gyrus	L	−8, −94, −14	3.92; 22	No suprathreshold cluster			
	Inferior frontal gyrus	R	44, 16, −4	3.52; 7				
9	Middle occipital gyrus	R	8, −100, 24	5.46; 112	Cuneus	L	−6, −96, 14	4.53; 41
	Lingual gyrus	R	20, −94, −10	3.84; 14	Lingual Gyrus	R	16, −80, −14	4.01; 101
	Fusiform gyrus	R	34, −82, −20	3.54; 7	Inferior frontal gyrus	L	−40, 32, 12	3.54; 13
10	Superior frontal gyrus	L	−28, 50, 38	3.64; 7				
	Middle occipital gyrus	R	36, −76, 14	3.51; 8	No suprathreshold cluster			
	Lingual gyrus	R	34, −70, −8	3.43; 16				
11	Middle occipital gyrus	L	−16, −96, 10	5.11; 352	Superior temporal gyrus	L	−62, −32, 6	3.87; 35
	Lingual gyrus	R	16, −84, 0	5.31; 341	Inferior frontal gyrus	L	−62, 30, 4	3.62; 10
	Fusiform gyrus	L	−34, −48, −14	4.44; 25	Fusiform gyrus	R	60, −6, −30	3.33; 5
	Cuneus	R	14, −98, 2	3.32; 9				
	Middle frontal gyrus	L	−38, 58, −6	4.60; 6				
	Parahippocampal gyrus	L	−44, −90, 20	3.85; 5				
	Inferior temporal gyrus	L	−58, −70, −4	3.62; 5				

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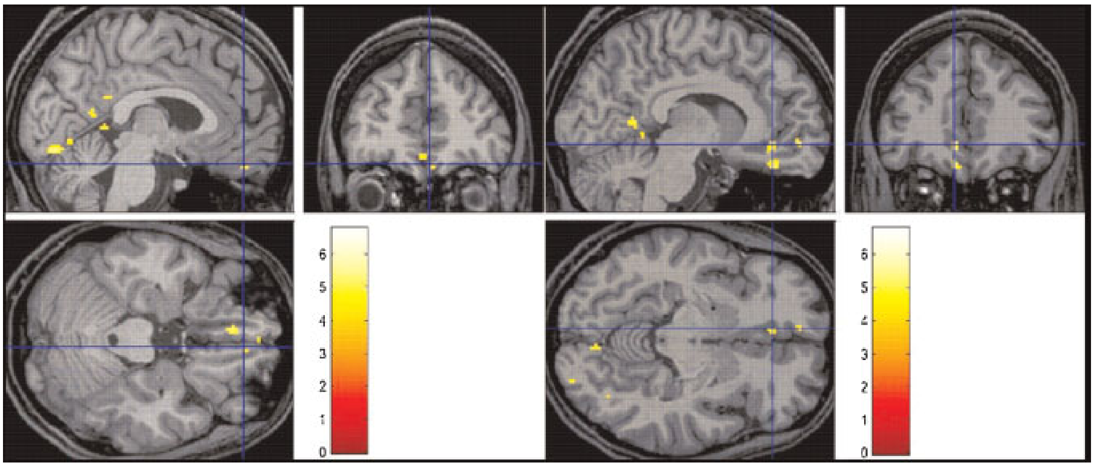

Figure 2. Results on the single subject level by contrasting attractive versus unattractive packages ($T = 4.25$, $p < 0.005$ (FDR), extent threshold $k = 5$) (1) left activations in the orbitofrontal cortex (2) right activation in the anterior and posterior cortex.

The most significant cortical activity changes between unattractive minus attractive packages have been observed within areas of the left medial frontal and left superior frontal cortex (MNI: $x = -4$, $y = 40$, $z = 48$, $T = 7.69$, $p < 0.001$, cluster size $= 12$/MNI: $x = -10$, $y = 10$, $z = 64$, $T = 5.92$, $p < 0.001$, cluster size $= 10$), the left middle frontal gyrus (MNI: $x = -32$, $y = 52$, $z = 12$, $T = 5.39$, $p < 0.001$, cluster size $= 5$), and the insula (MNI: $x = -46$, $y = 8$, $z = 4$, $T = 4.17$, $p < 0.001$, cluster size $= 8$).

Discussion

In neuroscience there is evidence that the brain processes several visual stimuli in a different way (Aharon *et al.*, 2001; Kenning *et al.*, 2007b). According to these findings we found that attractive and unattractive packages are able to trigger differing neural activation patterns.

Single subject analysis

On the single subject level, we found significant activity changes in the MPFC, the orbitofrontal cortex, the anterior cingulate cortex, and the posterior cingulate cortex. These findings indicate that regions associated with reward processing, decision making, and episodic memory may be involved in choices that include attractive packages.

A crucial region for human decision-making is the MPFC. Through the assessment of rewards and punishment, it may help to select the optimal choice (Bechara *et al.*, 2000; Rushworth *et al.*, 2004). Beyond this, activity changes in this brain structure might reflect individual preferences, because the MPFC seems to be involved in the evaluation of sensory stimuli (O'Doherty *et al.*, 2001; Small *et al.*, 2001; McClure *et al.*, 2004). Kenning *et al.* (2007b) were able to show that this brain area is also activated by evaluating attractive ads. Hence, it could be possible that activity changes in this area reflect individual preferences regarding package design and the selection of the optimal evaluation choice.

The activation of the orbitofrontal part of the MPFC may provide evidence that attractive packages trigger emotions to a stronger degree than unattractive packages. This brain structure seems to be involved in the generation of emotions, the emotional evaluation of incoming stimuli, the prediction of expected rewards and decision-making (Breiter *et al.*, 2001;

DOI: 10.1002/cb

Statistics: *p-values adjusted for search volume*

set-level p	set-level c	cluster-level $p_{corrected}$	cluster-level k_E	cluster-level $p_{uncorrected}$	voxel-level $p_{FWE\text{-}corr}$	voxel-level $p_{FDR\text{-}corr}$	voxel-level T	voxel-level $(Z_{\equiv})$	voxel-level $p_{uncorrected}$	mm	mm	mm
0.003	14	0.283	13	0.002	0.179	0.179	9.70	4.74	0.000	28	-80	-4
		0.980	6	0.026	1.000	0.473	6.89	4.09	0.000	-34	-68	-4
		0.019	23	0.000	1.000	0.473	6.83	4.08	0.000	32	-90	-10
		0.003	30	0.000	1.000	0.473	6.78	4.06	0.000	32	-96	4
					1.000	0.588	4.67	3.32	0.000	34	-88	6
		0.283	13	0.002	1.000	0.473	6.35	3.93	0.000	-44	-76	6
		0.000	45	0.000	1.000	0.473	6.21	3.89	0.000	6	-98	16
					1.000	0.552	5.63	3.70	0.000	14	-98	14
		0.928	7	0.017	1.000	0.473	5.93	3.80	0.000	36	-70	40
		0.072	18	0.000	1.000	0.473	5.88	3.78	0.000	46	-80	6
		0.283	13	0.002	1.000	0.473	5.78	3.75	0.000	20	-96	20
		0.980	6	0.026	1.000	0.588	5.00	3.46	0.000	-8	-106	12
		0.588	10	0.006	1.000	0.588	4.95	3.44	0.000	-26	-90	-8
		0.928	7	0.017	1.000	0.588	4.92	3.43	0.000	34	-54	-4
		0.469	11	0.004	1.000	0.588	4.78	3.37	0.000	-16	-96	-8
		0.928	7	0.017	1.000	0.588	4.75	3.36	0.000	12	-100	-4

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 4.14, p = 0.001 (1.000) {p<0.001 (unc.)}
Extent threshold: k = 5 voxels, p = 0.039 (0.997)
Expected voxels per cluster, <k> = 1.139
Expected number of clusters, <c> = 5.96
Expected false discovery rate, <= 0.62

Degrees of freedom = [1.0, 10.0]
FWHM = 5.6 5.5 5.6 mm mm mm; 2.8 2.7 2.8 {voxels};
Volume: 1360504; 170063 voxels; 6995.9 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 21.43 voxels)

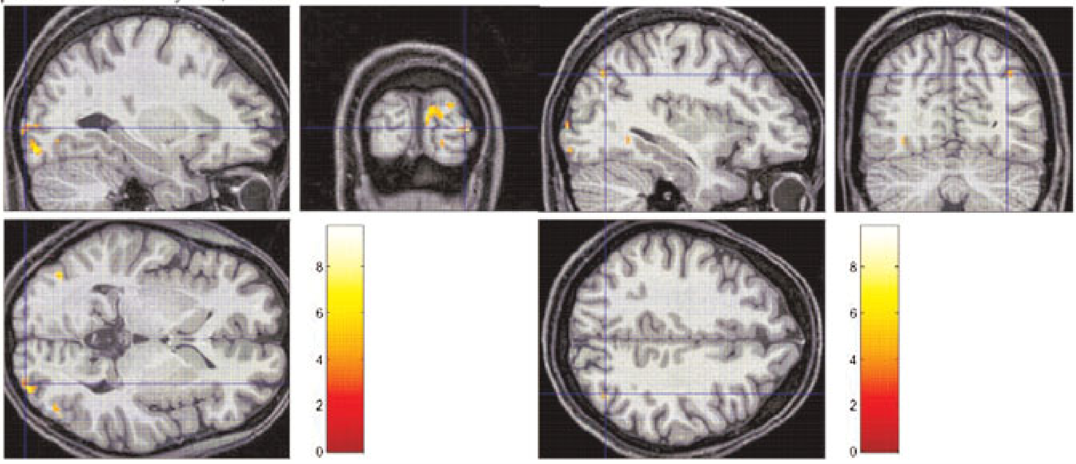

Figure 3. Results on the group level contrasting attractive versus unattractive packages ($p < 0.001$ (uncorrected), extent threshold $k = 5$), (1) above: statistics of the group analysis, (2) left: activations in the occipital lobe, and (3) right: activation of the precuneus.

Dalgleish, 2004; O'Doherty, 2004). Recent studies from consumer neuroscience showed that the orbitofrontal cortex can also be activated by emotional engaging ads (Ambler *et al.*, 2000), attractive objects such as sports cars (Erk *et al.*, 2002) and beautiful faces (Aharon *et al.*, 2001).

The anterior cingulate cortex is in general associated with emotions, response selection, initiation, motivation, reward-based learning, and goal-directed behavior (Devinsky *et al.*, 1995; Bush *et al.*, 2002; Dalgleish, 2004). Due to its close connection to other brain structures, such as the orbitofrontal cortex, this brain area might be concerned with integrating implicit information and emotions in the decision-making process (Bush *et al.*, 2002; Deppe *et al.*, 2005a, 2007). Beyond this, the anterior cingulate cortex seems to be involved in the regulation of cognitive and emotional

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Statistics: *p-values adjusted for search volume*

set-level		cluster-level			voxel-level					mm mm mm		
p	c	$p_{corrected}$	k_E	$p_{uncorrected}$	$p_{FWE\text{-}corr}$	$p_{FDR\text{-}corr}$	T	$(Z_{\equiv})$	$p_{uncorrected}$			
0.041	11	0.367	12	0.003	1.000	0.582	7.69	4.31	0.000	-4	40	48
		0.997	5	0.039	1.000	0.655	6.49	3.98	0.000	-20	-80	22
		0.588	10	0.006	1.000	0.655	5.92	3.80	0.000	-10	10	64
		0.980	6	0.026	1.000	0.655	5.68	3.71	0.000	-38	16	20
		0.928	7	0.017	1.000	0.655	5.61	3.69	0.000	36	-50	18
		0.980	6	0.026	1.000	0.655	5.55	3.67	0.000	-40	30	18
		0.997	5	0.039	1.000	0.655	5.39	3.61	0.000	-32	52	12
		0.216	14	0.002	1.000	0.655	5.36	3.60	0.000	-52	-38	2
		0.980	6	0.026	1.000	0.655	5.01	3.47	0.000	-10	46	40
		0.980	6	0.026	1.000	0.655	5.00	3.46	0.000	-2	24	56
		0.980	6	0.026	1.000	0.655	4.67	3.33	0.000	20	-52	-30

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 4.14, p = 0.001 (1.000) {p<0.001 (unc.)}
Extent threshold: k = 5 voxels, p = 0.039 (0.997)
Expected voxels per cluster, <k> = 1.139
Expected number of clusters, <c> = 5.96
Expected false discovery rate, <= 0.66

Degrees of freedom = [1.0, 10.0]
FWHM = 5.6 5.5 5.6 mm mm mm; 2.8 2.7 2.8 {voxels};
Volume: 1360504; 170063 voxels; 6995.9 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 21.43 voxels)

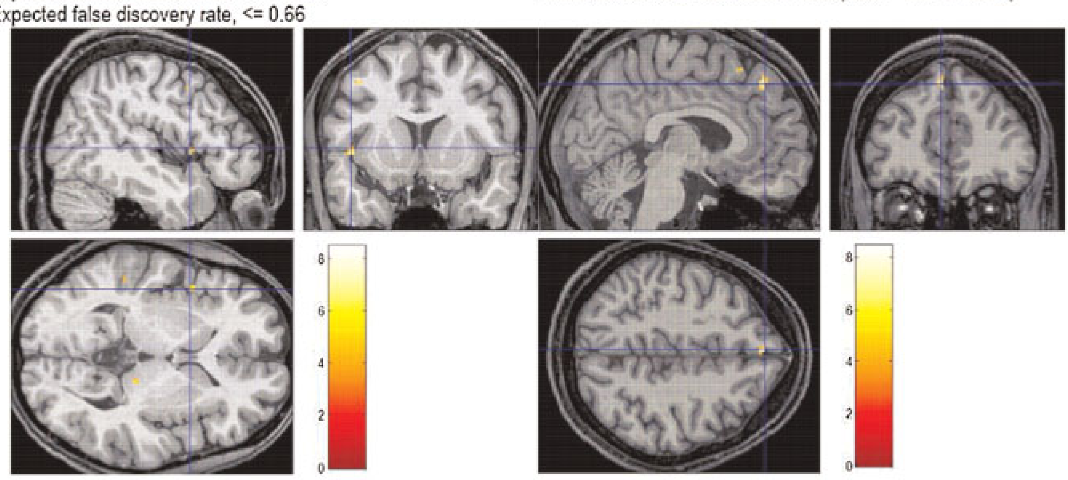

Figure 4. Results on the group level contrasting unattractive versus attractive packages (1) above: statistics of the group analysis ($p < 0.001$ (uncorrected), extenthreshold $k = 5$) (2) left: activations in the insula ($p < 0.005$ (uncorrected), extent threshold $k = 5$), and (3) right: activations in the medial frontal gyrus ($p < 0.001$ (uncorrected), extent threshold $k = 5$).

processing, through the salience evaluation of emotional and motivational information, it might help to adjust corresponding emotional responses (Bush *et al*., 2002). Deppe *et al*. (2007) confirmed the assumption that the anterior cingulate cortex is an important structure for the integration of emotions and implicit information in the decision-making process. In a similar vain Erk *et al*. (2002) showed that attractive objects such as sports cars could induce activity changes in the anterior cingulate cortex as well. From this, we can assume that attractive packages may induce stronger emotional responses and are therefore perceived as a rewarding stimulus in contrast to unattractive packages.

The posterior cingulate cortex is often characterized as ''evaluative,'' because it seems to be involved in supervising evaluative functions such as assessing sensory information or the organisms own behavior as regards spatial orientation and episodic memory (Vogt *et al*., 1992; Maguire, 2001; Bush *et al*., 2002). From the measured activity changes, it can be deduced that attractive packages trigger attention and the integrating

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of incoming information with background knowledge to a higher degree than unattractive packages. Deppe *et al.* (2005b) also reported increased activations in the posterior cingulate cortex during decisions, which involve the favorite, the ''first choice brand.'' These results are consistent with our findings, because we can assume that the favorite brand is also evaluated as ''very attractive.''

Interestingly, we additionally observed significant activation in the fusiform gyrus by 6 out of 11 subjects. This brain region is mainly associated with the recognition of faces (Kanwisher *et al.*, 1997; McCarthy *et al.*, 1997). Furthermore, there is evidence that it plays a crucial role in color processing (Allison *et al.*, 1993; Howard *et al.*, 1998) and word recognition (McCandliss *et al.*, 2003). We can deduce that activity changes in this area could be interpreted as a higher degree of visual attention and a more intensive visual processing of the attractive packages.

Group level analysis

On the group level, we observed, consistent with the results on the single subject level that attractive packages seem to induce activity changes in areas within the occipital lobe. These results are in accordance with other studies which observe the perception of attractive versus unattractive stimuli (Kenning *et al.*, 2007b) or the processing of attractive objects (Erk *et al.*, 2002). The interconnected higher visual association areas (cuneus, middle occipital cortices) are crucial for the processing of visual stimuli and seem to play an important role for feature extracting, shape recognition, attention integrating functions (Erk *et al.*, 2002; Goodale *et al.*, 1994; Grill-Spector, 2003; Kastner and Ungerleider, 2000) as well as for the processing of colored stimuli (Courtney and Ungerleider, 1997; Vartanian and Goel, 2004). Therefore, we assume that significant cortical activity changes within regions of visual cortices may reflect stronger visual attention induced through the presentation of attractive packages (Erk *et al.*, 2002; Shimojo *et al.*, 2003). Secondly, we can surmise that there is a positive correlation between cortical activity in areas associated with shape and color recognition and the shape and color differences of our stimulus material (Courtney and Ungerleider, 1997; Grill-Spector, 2003; Goodale *et al.*, 2004). An ex-post on-sight analysis of the stimulus material confirmed this assumption, because attractive packages generally varied in both shape (oval, rectangular, and abstract shapes) and color (multicolored and bright) to a stronger extend than unattractive packages. From these results, we can conclude that attractive packages are more likely to generate attention and are therefore regarded more intensively and carefully by the consumer.

Furthermore, our assumption that attractive packages may stimulate a higher level of attention and visual processing, was supported by the measured activity changes in the precuneus (parietal lobe). The precuneus seems to be involved in shifting the attention between different object features (Nagahama *et al.*, 1999; Cavanna and Trimble, 2006). Further functions are related to an involvement in spatial information processing, retrieval of episodic memory and self-processing (Kjaer *et al.*, 2001; Cavanna and Trimble, 2006).

By contrasting unattractive versus attractive packages, we found significant differences within regions of the frontal lobe, especially the medial frontal gyrus, the middle frontal gyrus and the superior frontal cortex and within the insula.

Areas of the medial, middle, and superior frontal cortices are seen to be involved in processing of spatial working memory (Courtney *et al.*, 1998), detection of unfavorable outcomes, responses to conflicts, and in processing uncertainty (Ridderinkhof *et al.*, 2004; Volz *et al.*, 2005). Furthermore, they showed increased activation with increasing uncertainty (Volz *et al.*, 2005).

The activation in the insula region is consistently present in neuroimaging studies of pain and distress, hunger and thirst, autonomic arousal, and unfairness (Sanfey *et al.*, 2003). This region has also been named

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in studies of emotion, in particular involvement in the evaluation and representation of specific negative emotional states (Calder *et al*., 2001). In a recent, more consumer behavior related study, Knutson *et al*. (2007) showed that excessive prices activated the insula and deactivated the MPFC prior to the purchase decision. Another study showed significant activation within the insula associated with expected risk (Knutson and Bossaerts, 2007).

Looking at the different interpretations of the activated brain regions, we can assume that the evaluation of unattractive packages is in general associated with uncertainty and negative emotions. This might at least partly explain a higher rejection rate of products with unattractive packages compared to products with attractive packages.

Implications for marketing research and practice

We believe that our findings might offer some important insights for marketing research and practice. First, the behavioral analysis showed that pre-evaluated packages were almost consistently deemed as attractive or unattractive between different groups of participants. Furthermore, an important fact is that a specific attitude toward the attractiveness of packages could bias the strength of cortical activity within areas associated with the processing of visual stimuli, attention, and reward.

Secondly, because of highly increased activities in visual areas of the occipital lobes on the group level and especially in the fusiform gyrus on the individual level during the evaluation of attractive versus unattractive packages, we can assume that attractive packages are able to attract the attention for a product. Our results confirm findings from marketing research that the external appearance of a product at the point of sale can influence the decision-making process of the consumer to a high degree (Schoormans and Robben, 1997). However, further research has to be done by differentiating the subjects into particular consumer profiles (e.g., impulsive vs. conservative) or by an explicit investigation of their attitude toward functions of packages (attractiveness versus information/safety).

Thirdly, it could be possible that attractive packages, due to attention and memory effects contribute to brands much better than unattractive ones. *Vice versa* and because of their often use for private labels, the question arises, how and if unattractive packages could impact branding. We suggest that unattractive packages will have some negative influence (expected risk, uncertainty) on brand equity and thus marketing management should take care of the valence of one specific package.

Fourthly, our study might provide a first glimpse on the neurophysiological basis of packaging, brand-preference, and purchasing. While Kenning *et al*. (2007b) revealed that ad-liking is associated with significant activity changes in the ventral striatum, especially the nucleus accumbens; our study was not able to show that attractive packages might modulate brain activity in similar brain regions on the group level. Nevertheless the single subject analysis already revealed first insights that attractive packages can act as rewarding stimulus and lead to an increased activation in reward processing areas (O'Doherty, 2004). Against this background, we can assume that marketing stimuli, such as design, packaging, or pricing also have a quite comparable impact on the activity in the striatum. While there is first additional evidence from neuroscience that this assumption holds true (Erk *et al*., 2002; Knutson *et al*., 2007) further research should expand and broaden these findings.

Finally, the existence of differences between the evaluations of attractive versus unattractive packages leads to the statement that variation and ''idealization'' of package design (Bloch, 1995) is an important claim. Accordingly, we hope that our study stimulates further research on the neural correlates of packaging.

Limitations and future research

The present study is the first that investigated the neural correlates of attractive packages.

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Because of its explorative character, we faced some limitations and directions for further research.

The interpretation of our empirical findings is based on binary decision-making tasks conducted in a controlled laboratory environment by a small-size sample of younger adults and thus does not reflect the richness of packaging perception by a broader audience in a real-world situation, that is the point-of-sale. Hence, further refinement of the experimental design, such as integrating more mobile brain imaging methods, will be needed in the future. Because of our relatively small sample-size and specific results on the individual level, we could neither accept nor reject our assumption of an interaction between reward related regions and the evaluation of attractive packages in a definite manner. Especially for this activation pattern, further research is necessary, for example, by investigating differences in age, gender, or traits. Furthermore, we focused only on the link between brain processes of paper-based packages. Future studies should broaden our findings by investigating other forms of packages. Another important research area of the psychological effects of attractive packaging is the impact of brands on the decision process. Therefore, it is necessary to examine the influence on the evaluation of attractiveness when two identical products of the same brand are wrapped in packages with different designs. Because of various possible confounders that we did not exclude in the present study (e.g., color, brand, or familiarity) future research is needed to investigate the influence of these factors on the decision process. In order to specify and refine the data analysis, a voxel by voxel correlation between the overt responses to the different packages and the fMRI BOLD response data to those packaging could further clarify our results. Finally, due to methodological reasons, our study ignores the influence of other senses, such as touch and feel, might have on the evaluation of the packages. In principle, it is possible to employ fMRI when subjects evaluate the touch of a certain package, and future studies might address this issue as well.

Conclusion

Why do some packages gain more attention from consumers than others do? What are the underlying mechanisms accompanied with this phenomenon? To answer these questions, we applied fMRI to gain first exploratory insights in the way the brain processes packages. Non-invasive functional brain imaging was employed to investigate brain activities of 11 healthy subjects during decision-making on package-attractiveness. One key finding of our study is that attractive packages induce specific cortical activity changes which are interestingly involved in areas related to visual attention and memory (group-level) as well as reward-related areas on single subject observation. In contrast, unattractive packages are accompanied with activity changes in brain areas associated with the perception of response conflict, uncertainty, disgust, and expected risk. While we assume that these insights might help to answer the above-mentioned questions, it will be interesting to learn more about the consumers' brain as the organ of purchase decisions. Furthermore, we hope that our study will stimulate both further research that concentrates on the brain as the organ of purchase decisions and investigations that focus explicitly on packaging.

Acknowledgements

We would like to thank Prof. Bernarding for the provision of the technical equipment, Pro Carton and Smurfit Kappa for their effort and cooperation as well as Jürgen Bihler, Hans-Werner Brocke, Johannes Berentzen and Tim Eberhardt for their excellent work wihtin the Pre-Study. Furthermore we thank Mirja Hubert for her expert help during the fMRI–tasks and data–analysis.

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Peter Kenning is Professor of Marketing at Zeppelin University, Germany. His primary research interests are consumer behavior, consumer neuroscience, neuroeconomics, and marketing management. His work has been widely published, for example, in *International Journal of Advertising*, *Management Decisions*, *Journal of Product and Brand Management*, and *Advances in Consumer Research*, and in *Journal of Neuroimaging*, *NeuroReport*, and *Brain Research Bulletin*. He has presented papers at numerous conferences including AMA Conference, EMAC, and ACR. He has received several best paper awards and grants for his work.

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