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Organic or popular brands—food perception engages distinct functional pathways. An fMRI study

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Abstract: *Introduction*: Organic food has become increasingly popular with consumers. People seem to recognize it as a valuable alternative to popular brands from conventional food producers. Still, the basis of such consumer behavior remains unclear, with the literature supporting motivations ranging from health-related to more hedonic. *Methods*: To investigate the underlying brain processes, we looked for neural correlates of the perceptions of two types of psychological added value that brands could provide (popular/organic). Eighteen subjects were exposed to logos of brands of either category for the very same types of food that was typed below the logo (i.e. French fries) and blood-oxygen-level dependent brain activation was recorded using functional magnetic resonance imaging (fMRI). *Results*: The results show higher activations in medial prefrontal cortex for popular brands, as expected with respect to the existing literature on decision-making and self-control. For organic brands, we found relatively higher activations in dorsolateral parts of the prefrontal cortex. *Conclusions*: Our study contributes data from the food field to the converging evidence in the literature that the lateral and medial parts of the prefrontal cortex have discrete and independent influences on decision-making: Brand information (as a secondary inducer) substantially affects the processing of food stimuli (as a primary inducer).

ABOUT THE AUTHORS

The study was conducted as part of a project on obese patients and psychological effects of gastric surgery focusing on normative aspects in everyday consumer goods' brands. Our group is interested in neural foundations of everyday behavior in the market economy and underlying economic as well as social value representations that reflect consumer judgments and ethical implications of marketing actions.

PUBLIC INTEREST STATEMENT

Organic food has become increasingly popular with consumers. People seem to recognize it as a valuable alternative to popular brands from conventional food producers. Still, the basis of such consumer behavior remains unclear, with the literature supporting motivations ranging from health-related to more hedonic. We were interested in brain processes going on when a consumer is exposed to either a conventional, well-known food brand or, on the other hand, a food brand that stands for organic food. In another study, subjects valued the taste of Pepsi Cola higher than Coca-Cola only when they did not know that it was Pepsi.

We found different brain areas to be involved in evaluating popular conventional versus organic brands that depict dissimilar value processing and might explain why organic brands stay behind in sales although consuming organic food is considered very positive by consumers.

Subjects: Cognitive Neuroscience; Social Neuroscience; Sustainable Development; Marketing

Keywords: fMRI; organic food; dietary choice; brands; decision-making; consumer neuroscience and neuromarketing

1. Introduction

Organic food, a presumably healthier or tastier alternative to conventional food, is becoming increasingly popular in Western societies. The land area cultivated in organic agriculture in Europe increased from 0.3 million hectares in 1990 to 10.0 million hectares in 2010. The total revenue from organic food nearly doubled from 10.8 billion € in 2004 to 19.6 billion € in 2010. The same growth has been reported from Germany, today grossing 6.3 billion € in organic food; the per capita consumption is on an intermediate level in Europe, comparable with that of the United States (Willer & Kilcher, 2012).

In spite of the remarkable relative gains of organic food over the last ten years, the market share of organic versus non-organic foods remains small. Still, there is a gap between consumers' positive attitude toward organic food and its relatively low market share. The share of market for organic food is 2.9% in all of Europe and 3.5% in Germany (Willer & Kilcher, 2012). This contrasts with surveys suggesting that four out of five consumers are willing to pay more for organic food (Plaßmann, Hamm, & Sahm, 2009).

The reasons for consumers' decisions toward or against organic food are still under debate and span brand effects, demographic variables, and organic labels (Bauer, Heinrich, & Schäfer, 2012; Larceneux, Benoit-Moreau, & Renaudin, 2011; Ngobo, 2011). Organic food is considered healthier and more environmentally friendly compared to conventional food and is linked to a certain respectable lifestyle. Pearson, Henryks and Jones (2010) list three main issues, all driven by cognitive deliberation by the consumer, who ascribes advantages to organic food in the topics "health", "quality" and "concern for the environment". Aertsens, Verbeke, Mondelaers and Van Huylenbroeck (2009), while accepting the importance of cognitive factors, also suggest more affective components of a decision toward organic food, such as "hedonism", "stimulation" and "self direction" (based on values by Schwartz {Schwartz:2006ue}).

It is highly plausible that the difference in explicit attitudes toward organic food and the actual buying decision is influenced by psychological issues such as the long-known social desirability and other confounding influences of questionnaire-based research (Edwards, 1957; Nisbett & Wilson, 1977). Functional magnetic resonance imaging (fMRI) has been introduced to the field of consumer science as well because it is able to reveal brain processes relevant to buying decisions and evaluation of goods that are either unconscious to the subject or not subject to conscious manipulation in behavioral research (Bargh, 2002; Fazio & Olson, 2003; Maison, Greenwald, & Bruin, 2004).

In recent years, consumer neuroscience has yielded interesting insights into how psychological issues such as trust and affection toward a brand can assign a psychological added value to a product and influence decision-making without the conscious knowledge of the consumer. Investigating consumer-related decisions, sociocultural effects of brand image (Schaefer & Rotte, 2007), familiarity (McClure et al., 2004), and marketing actions (Plassmann, O'Doherty, Shiv, & Rangel, 2008) could be found that affect remembered and assigned value. A set of value signals accompanying product evaluation and buying processes have been identified as important for brand decisions (Plassmann, Ramsøy, & Milosavljevic, 2012).

In a seminal study, McClure et al. (2004) found that subjects preferred soda with a strong brand (Coca-Cola) over a weak brand (Pepsi Cola) in a subjective rating if they were given it in a labeled mug, not in a neutral one. The results of further neuroimaging research pointed to a network engaging the orbital and medial prefrontal cortex (mPFC), often more precisely identified as its ventral part (vmPFC), as predominantly activated in value-based choice processes (De Martino, Fleming, Garrett, & Dolan, 2012; Deppe, Schwindt, Kugel, Plaßmann, & Kenning, 2005; Plassmann et al., 2008; Sanfey, Loewenstein, McClure, & Cohen, 2006). Simple choices as deciding between two given options are assumed to be performed by assigning decision values to the option to choose (Montague & Berns, 2002) and computation of the decision values seems to take place in ventromedial prefrontal cortex. Decision value computation involves other regions of interest as well (Sokol-Hessner, Hutcherson, Hare, & Rangel, 2012). Similar results reflect also brand-like differences like high price vs. low price tags in wines (Plassmann et al., 2008). fMRI studies dealing explicitly with brand-related decisions (more vs. less rewarding brands) also found activations in medial prefrontal value-sensitive networks (Erk, Spitzer, Wunderlich, Galley, & Walter, 2002; Falk, Berkman, & Lieberman, 2012; Schaefer & Rotte, 2007). Knutson, Rick, Wimmer, Prelec and Loewenstein (2007) sum up their data concerning packaged-goods food stimuli by naming such activations the “neural predictors of purchase”.

In contrast to the more affective function of areas within the mPFC, areas of the more lateral parts of the cortex, especially the dorsolateral prefrontal cortex (dlPFC) are engaged in deliberative cognitive processes in decision-making (Hare, Camerer, & Rangel, 2009; Kahnt, Heinzle, Park, & Haynes, 2011; Philiastides, Auksztulewicz, Heekeren, & Blankenburg, 2011; Steinbeis, Bernhardt, & Singer, 2012). According to recent neuroimaging studies dorsolateral prefrontal cortex is involved in computation of actions and goals: Regarding recent models, it is suggested that dlPFC either modulates valuations (adding input) or might interrupt or override already computed valuations (Kable, 2010).

The ability to control one’s impulses (self-control) is crucial when it comes to primary triggers such as tempting (and unhealthy) food. He et al. (2014) performed a go-/nogo-task with high and low calorie food in normal weight adolescents. They have shown a higher activation in reward-activated striatum for high vs. low calorie food go trials and a higher activation in prefrontal and orbitofrontal areas during nogo-trials than go-trials. They referred to both areas mentioned as the impulsive vs. reflective system and found them to be correlated with participants’ body-mass-index and their consumption of high calorie-foods (for the prefrontal reflective system, the correlation was inverse). This suggests a direct effect of primary inducers reflecting individual habits. More attentional focus on long-term goals, in this regard healthiness, was found to affect behavioral choices employing dorsolateral prefrontal modulation (Hare, Malmaud, & Rangel, 2011). It seems that buying decisions that we call “rational” in everyday life can be associated with activation in the dlPFC, that may override the affective decision of the vmPFC. In the ongoing debate concerning organic food, activation of the dlPFC in contrast to control or conventional food could point in the direction of “health”, “quality” and “concern for the environment”.

A study by Bruce et al. (2014) reflected reward-related activation for unhealthy food brand logos in children, but did not provide data concerning specific neural correlates of healthy or organic food. The first fMRI study directly addressing the difference of organic and conventional (but not: popular) food was conducted in Germany: Linder et al. (2010) found activations of gain- and reward-related brain structures (here: ventral striatum) when subjects were presented with food stimuli with the local label for organic food (“BIO”). However, the data were analyzed in comparison to a control condition that presented the very same food stimuli with the same “BIO” label simply crossed out. In this design, the reward activation was thus apparently driven by an added value vs. non-value condition: Either a positive value is added by the organic label, or the same attribute is removed, thus providing negative value to the product. Consequently, the authors based their hypotheses on a number of other studies measuring rewarding stimuli against less rewarding ones (Beaver et al., 2006; O’Doherty, Deichmann, Critchley, & Dolan, 2002). Especially obese individuals (who may have a tendency to overeating) have been found hyper-responsive in reward regions such as vmPFC compared to lean individuals when responding to high calorie food compared to low-fat labeled food (Ng, Stice, Yokum, & Bohon, 2011).

The results of Linder et al. (2010), though of great interest for the research on brands and rewards in general, do not precisely reflect differences triggered by the choice between distinct positive added values: Not the comparison of branded foods of organic or non-organic origin are investigated, but rather differences triggered by presence or absence of the label of origin itself. Here, we are interested in overall effects of such kind of decision value computation provided by the brand which is either a popular brand or a brand linked to organic production. Both long- and short-term features (tastiness and healthiness) of food stimuli are investigated with additional brand information (popular vs. organic). Since surveys present a broad range of motivations for organic food consumption, those refer to short- as well as long-term goals. A brain imaging study disentangles these effects employing brands as selection criteria. Brands are expected to provide a positive effect based on value predicted by consumers (Plassmann et al., 2012).

To directly assess the question of the neural correlates of brand-related decision processes concerning organic brands, we set up two conditions that both integrate possible influences of brands—one with the positive added value of well-known organic food brands, the other with the positive added value of strong popular but conventional food brands. Our hypothesis, based on the neuroscientific literature and the results of questionnaire-based research on organic food preferences, was that organic and popular brands would yet elicit distinct neural patterns of activations in value-related areas described above.

As the literature suggests that both cognitive-deliberative and affective components are considered advantageous by consumers of organic food, we were interested in finding neural correlates supporting one stance or the other based on brand perception along with purchase decisions. Our main question was whether fMRI data can elucidate the different neurocognitive mechanisms evoked by different types of brands. Can we reveal distinct functional pathways pointing toward distinct processes in decision-making of organic and popular branded food shopping?

2. Method

2.1. Participants

Twenty-three healthy, right-handed subjects (9 female, aged 27–47, $M = 37.09$ years, SD = 7.60 years) with normal or corrected-to-normal vision took part in the experiment. Subjects reported their body mass index (BMI). With respect to age and sex, all participants were in the range of normal, healthy weight (female BMI: $M = 23.04$, SD = 1.61; male BMI: $M = 23.91$, SD = 1.65, a BMI of 18.5–25 is considered normal range). None of them reported neurological diseases; the experiment was conducted in accordance with the Declaration of Helsinki and approved by the local academic ethics committee at LMU Munich. Subjects gave written informed consent and received financial reward (50 €) for participation. Subjects were instructed not to eat for 2 h before the experiment, sessions took place between 10 am and 5 pm.

2.2. Stimuli

Participants were exposed to a selection of stimuli. Six stimuli represented popular German food brands of conventional origin (e.g. Dr Oetker), and six represented different brands of organic origin (e.g. Demeter). Both sets of stimuli represented the same types of food. The different types included vice food such as French fries or chocolate bars (cf. Table 1) for all types of food and brands. Brands covered a selection of well-known producers in Germany taken from popularity rankings and were classified into the food types by a behavioral pre-study (brands were assigned to given food types, and top six of each set were used as stimuli) by the subjects.

Subjects were asked to rate brand strength, attractiveness, healthiness, tastiness and frequency of consumption on a 4-point scale (4 = very high to 1 = very low). Comparing differences between means of popular and organic brands, significant differences were found in all items but frequency of consumption ($M_{popular} = 2.25$, $SD_{popular} = 0.40$; $M_{organic} = 1.96$, $SD_{organic} = 0.29$; $t(10) = 1.47$, $p = 0.174$). Strength ($M_{popular} = 3.59$, $SD_{popular} = 0.29$; $M_{organic} = 2.39$, $SD_{organic} = 0.17$; $t(10) = 8.61$, $p < 0.001$) and attractiveness ($M_{popular} = 2.97$, $SD_{popular} = 0.19$; $M_{organic} = 2.38$, $SD_{organic} = 0.21$; $t(10) = 5.13$, $p < 0.001$) referred to objective and subjective rating of the brands. Healthiness ($M_{popular} = 1.90$, $SD_{popular} = 0.29$;

Table 1. Corresponding brands for each food type.

Popular brand	Organic brand	Food type
Chio	Demeter	Potato chips
Coppenrath & Wiese	Füllhorn	Cream cake
Dr. Oetker	BioBio	Frozen pizza
Ferrero	Alnatura	Nougat praline
Mars	Rapunzel	Chocolate bar
McDonald's	Naturland	French fries

Notes: Popular brands were taken from a trade journal website (www.lebensmittelzeitung.net) listing the top 100 German food brands. Matching organic brands were taken from a poll of the top organic food brands in Germany, conducted by the German magazine "Kraut und Rüben".

$M_{organic} = 2.73$, $SD_{organic} = 0.17$; $t(10) = -6.06$, $p < 0.001$) and tastiness ($M_{popular} = 2.90$, $SD_{popular} = 0.22$; $M_{organic} = 2.37$, $SD_{organic} = 0.17$; $t(10) = 4.66$, $p < 0.005$) referred to a general rating unconnected to actual (vice) food products.

During presentation of the stimuli, the type of food was indicated below the brand logo in the same typeset and color, all words being of approximately the same length. Six pictures of colored rectangles with the word "arrow" and an arrowhead pointing to the left or right were used as controls. All stimuli were presented against a white background. All pictures had the same image area and were equalized in luminance ($M = 154.98$, $SD = 5.99$).

2.3. Procedure

Stimuli were presented in blocks. The duration of each block was 18 s, and 3 stimuli were presented within a block. Each stimulus lasted 3 s, and a jittered interstimulus interval of 1,000–3,000 ms was applied. To encourage the participants' concentration, they had to decide block by block either whether the type of food by the brand shown was tasty or healthy, respectively, by pressing a button. Subjects were asked to rate tastiness or healthiness of the presented types of food by replying to the questions "Is this tasty?" or "Is this healthy?" with yes or No. Behavioral responses were given after stimulus onset (Figure 1). Inter-block-interval was switched randomly between 6 and 9 s. For analysis, response times and frequencies were analyzed. In the control stimulus blocks, colored rectangles containing an arrow pointing to either the left or the right was shown. Subjects had to press the left or right button according to the arrow's direction. Stimuli were presented in two separate pseudo-random orders to avoid order of sequence and other influencing effects. In total, 24 blocks were shown, eight blocks for each condition plus control, which adds up to 24 trials per

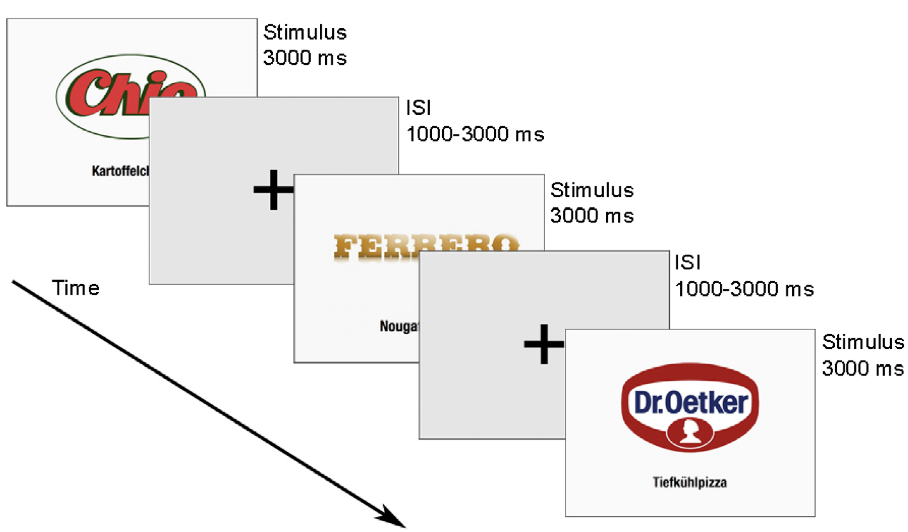

Figure 1. Task summary: One block consisted of three stimuli presenting either organic or popular food brands for 3 s, divided by an interstimulus interval (ISI) of 1–3 s.

condition (four repetitions of six labels each). The whole experiment took approximately 11 min. Stimuli were presented under computer control (Presentation, Neurobehavioral Systems, USA) onto a translucent screen viewed by subjects via a head coil-compatible mirror system. Interstimulus intervals were gray, and inter-block-intervals contained a fixation asterisk. Each participant underwent training runs and received individual instruction outside the scanner before the experiment. The order of stimuli and blocks was pseudo-randomized.

A 3.0-T whole body system (MAGNETOM Verio, Siemens, Germany) was used for fMRI scanning. Subjects viewed the stimuli via a mirror attached to the head coil. Their heads were fixated with comfortable foam cushions to minimize head movements. A T2*-weighted Echo-Planar Imaging (EPI) sequence was used for functional imaging (TR = 3,000 ms, TE = 30 ms, FA = 80°, number of slices = 36, slice thickness = 4 mm, inter-slice gap = 0.4 mm, interleaved acquisition, spatial resolution 1 mm^3, FOV = 192 × 192 mm, matrix = 64 × 64, in-plane resolution = 3 × 3 mm.

2.4. Data processing

Data were analyzed with SPM8 (Statistical Parametric Mapping; http://www.fil.ion.ucl.ac.uk/spm) run under MATLAB (MathWorks, Inc.). Because of T1 saturation effects, the first five volumes of each run were discarded. Functional volumes were realigned, coregistered, and spatially normalized into standard MNI space. Voxels were resliced to 2 × 2 × 2 mm and smoothed to 8 × 8 × 8 mm with a full-width at half maximum (FWHM) Gaussian kernel. The experimental conditions were modeled by a boxcar function convolved with the canonical hemodynamic response function.

At the first level, *t*-tests for both conditions (organic brands and popular brands) were computed against the control condition on a block-level. The individual contrast images were used for a random-effects second level analysis. To compare effects between organic and popular brands, corresponding contrasts were calculated. Statistical parametric maps on group level ($p < 0.01$) were cluster-level corrected (by family wise error (FWE), $p < 0.05$ with a cluster-size threshold of 50 voxels. Anatomical description was based on AAL atlas using SPM 8 AAL-toolbox (Tzourio-Mazoyer et al., 2002). During second-level analysis, three subjects had to be dismissed due to movement artifacts. Behavioral data were analyzed using SPSS 19 (IBM, USA).

3. Results

3.1. Behavioral results

For reaction times, a repeated-measures one-way ANOVA with reaction time as dependent variable and experimental block categories as independent variables was computed. To control for inflated α-error in multiple comparisons, results were corrected by the Bonferroni procedure.

Each block asked either for taste or for healthiness. Answers were given by pressing the corresponding "yes" or "no" button on a two-button device, respectively. Differences were found in the main effects: Comparing categories, reaction times for popular (M = 1.08 s, SD = 0.20) brands were significantly lower than for organic brands (M = 1.31 s, SD = 0.25): $F\text{category}\,(1, 20) = 47.82$, $p < 0.001$. No interaction between main effects was found. No significant main effect of categories could be observed (cf. Table 2 for segmented response time and responses). Slight deviation at balanced control task (50% arrow to left or right direction resp.) was due to three missing responses altogether.

3.2. fMRI results

Direct whole-brain subtraction analyses comparing popular and organic food brands were conducted to investigate differences between the food brands. Specific areas were found to be significantly more highly activated for each subtraction. Computing the contrast of popular > organic brands revealed activation in vmPFC (cf. Figure 2, Table 3). Comparing organic > popular food brands, activation in left dlPFC was found (cf. Figure 2, Table 4).

Table 2. Reaction times and responses for each task and experimental condition

Factor	Mean response time (SD) in sec.	# yes-responses (%)
Organic food brands	Healthy: 1.29 (0.25)	12.67 (22.01)
	Tasty: 1.34 (0.26)	3.00 (6.60)
Popular food brands	Healthy: 1.05 (0.19)	65.00 (28.40)
	Tasty: 1.12 (0.20)	73.10 (24.42)
Control (yes = arrow to left direction)	0.69 (0.12)	49.24 (2.05)

Note: Organic and popular food brand factors include responses regarding healthiness and tastiness.

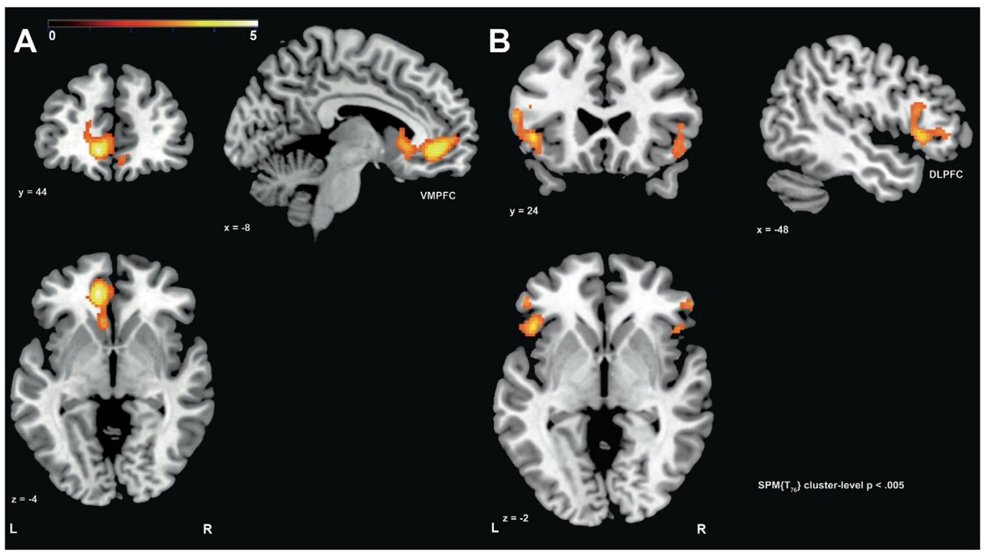

Figure 2. (A) Neurofunctional level of processing of popular > organic food brand; vmPFC = ventromedial prefrontal cortex, *x*, *y*, *z* coordinates, MNI. (B) Neurofunctional level of processing of organic > popular food brand; dlPFC = dorsolateral prefrontal cortex, *x*, *y*, *z* coordinates, MNI.

Table 3. Brain regions with higher activation in response to popular than to organic food brands

Cluster	Brain region	k_E	*Z*-value	*x*	*y*	*z*
1	vmPFC (superior frontal gyrus)	1,309	4.45	10	44	−4
2	Sensorimotor cortex	1,153	4.60	−46	−24	56

Notes: Right (R.) or left (L.) hemisphere. kE = size in voxels (2 × 2 × 2 mm). The *x*, *y* and *z* peak coordinates are in the MNI stereotactic space. *t*-test *Z*-values.

Table 4. Brain regions with higher activation in response to organic than to popular food brands

Cluster	Brain region	k_E	*Z*-value	*x*	*y*	*z*
1	R. inferior frontal gyrus	556	4.00	36	14	−16
2	L. inferior frontal gyrus	488	3.49	−46	24	−2

Notes: Right (R.) or left (L.) hemisphere. kE = size in voxels (2 × 2 × 2 mm). The *x*, *y* and *z* peak coordinates are in the MNI stereotactic space. *t*-test *Z*-values.

4. Discussion

In this study, we searched for neural correlates of the differences in psychological added value of organic food brands and popular food brands. We found distinct networks in the brain underlying the perceptions of the brands in the two conditions. Popular food brands show significantly higher activations in ventral areas of the medial prefrontal cortex (vmPFC), whereas organic food brands tend to activate more lateral parts of the prefrontal cortex (dlPFC, Broca's area). These findings are consistent with the neuroscientific literature to date, which indicates that the vmPFC activates more frequently in response to perception of positive affective stimuli and value (Bechara & Damasio, 2005; De Martino, 2006; Knutson et al., 2007; Lebreton, Jorge, Michel, Thirion, & Pessiglione, 2009) in general and to strong and popular brands in particular (Schaefer & Rotte, 2007) as well as to food brands in children (Bruce et al., 2014). The presented popular food brands, though not expensive or in other ways particularly rewarding, elicited brain activation comparable to prior neuroimaging studies dealing with rewarding stimuli.

When interpreting these data, we must remember that the brands in both groups were presented with the same words for the related food. The presented food was of possibly rewarding character (high calorie food) and thus potentially responsible for reward activations that were found in prior fMRI studies presenting pictures of high calorie food (Stoeckel et al., 2009). The restriction on vice foods was executed because thus we could control for possible differences of the type of food (healthy or not) that could have mixed up our conditions. We opted for vice food because here the differences between the influences of added psychological values from a popular brand on the one hand and an organic brand on the other hand promised to generate a more significant signal. However, the difference we report here is that we compared all popular brands with all organic brands, so that the type of food itself could not account for the relatively stronger activation of the mPFC.

Given that we executed whole brain analyses, these discrete activations of vmPFC in the popular brand condition are fairly striking. In our view, these neural data can be interpreted to indicate that strong popular brands elicit a reward activation themselves, regardless of what type of food is labeled by this brand. Conversely, activation to stimuli including chocolate might lack this activation, at least to some extent, if presented with a cognitively accepted but emotionally less appealing organic brand. However, this result is limited to high calorie vice food due to experimental setting. Behavioral data reveal that general expectations differed with respect to the brands' categories in strength, attractiveness, healthiness, and tastiness explaining the attributes of added value that each category contributes to.

The comparison of organic brands versus popular brands strengthens this assumption. Again, we find that our results are consistent with the literature, which identifies the lateral parts of the prefrontal cortex as underpinnings of more rational decisions (Krawczyk, 2002). The activations of dlPFC in the organic versus popular food condition can be viewed as a reference for the hypothesis that even well-known organic food brands are subject to cognitive deliberation. We may say that organic brands make us think about and integrate value attributes with high variability, but they do not force us to want them. A comparison of our results with the only other published fMRI study dealing with organic labels (Linder et al., 2010) sheds more light on the neural processes related to different food brands. Our colleagues found activations in reward-related areas in the organic food label condition but not in the condition with the label crossed out. They also reported activations of the dlPFC in the label condition. With another approach, Fregni et al. (2008) as well as Goldman et al. (2011) have shown the effect of inhibiting craving for food when using transcranial direct current stimulation (tDCS). They found reduced food cravings when stimulating right dlPFC positively (anode over right dlPFC, cathode over left dlPFC).

In the ongoing debate in food science about the process that leads to a positive decision toward organic food, our data provide an interesting argument, especially as the findings are not only based on explicit statements in questionnaires but are also derived from brain processes. Consumers may attribute high value to organic food cognitively, resulting in positive appraisals in cognitive dimensions such as the ones Pearson and colleagues (Pearson et al., 2010) identified: "health", "quality", "environment". Consumers may also provide similar socially expected appraisals in polls. However, they may not feel the rewarding impact of a strong popular brand.

He et al. (2014), with their distinction between impulsive and reflective systems, have shown that past purchasing decisions and individual predisposition have an effect on processing of high and low calorie foods. We could show a similar pattern but not based on the feature of calorie content, but rather abstract additional brand information. In line with these findings and with respect to Berns and Moore (2012), who found a significant positive correlation between reward-related areas and future purchasing decisions, the neural responses found here can be considered predictively for food evaluation on the level of cultural popularity. Kahnt et al. (2011) suggest that the variability of multi-attribute objects' expected values is encoded in dlPFC. The integration of potentially conflicting value attributions correlates with activity in this region. Apparently, integration with higher variability must be performed for organic food brands. Consumer behavior thus seems to be triggered not only by healthiness or tastiness but also by the strength of its brand. Esthetic packaging design, as described in the neuroeconomic literature (Reimann, Zaichkowsky, Neuhaus, Bender, & Weber, 2010), might also affect its perception.

While our results are in line with the research presented above, there are clearly some limitations as well: Main concern is the confounding factor that comes along with popular brands: They are probably more familiar to the subjects, they might generate higher involvement, and their connection to the respective food category might be closer. Behavioral reaction times suggest this as well: They were significantly lower for conventional brands which might be the effect of being more familiar and popular. While on one hand it was our intention to show this relationship and its neural correlates, on the other hand an experimental design would have benefitted from better control procedures. The statistics could have benefitted from a more pronounced description of stimuli as well. With regard to value-based judgments or decision-making, this confounders are well known {ODoherty:2014tg} and alternative explanations on the level of processing the attributes regarding the match with the category instead of the actual brand could be thought of. Another alternative explanation is the effect of self-control that might elicit higher activation in dlPFC while self-control was exercised {Hare:2009be}. To assess self-control, however, participant classification would be necessary based on individual goal values that can be compared in actual choice tasks. Still, it is important to emphasize that the observed results are rather reflecting an interaction of regions than two distinct computations. In a more general way, based on a structure-function-relationship of elaborating on brand logo stimuli, we could show that differentiable processes are taking place when consumers engage in judgmental tasks referring to food brands.

If we extend our argument even further into the societal and political aspects of the issue of organic food, its importance becomes even more apparent. Even as the health benefits of organic food for human beings are still under debate (Smith-Spangler et al., 2012), its production is undoubtedly more ecologically sustainable. The road to a healthier environment via more conscious consumption may, at least in part, be achieved through unconscious reward processes in the brain.

5. Conclusion

The study reveals that processing of food-related information (referring to primary inducers without actually presenting them visually) can be substantially affected by additional information such as branding of either popular convenience store brands or organic brands (considered as a secondary inducer). It regulates both healthiness and tastiness judgments. The same kind of high calorie food products are evaluated differently depending on being branded as conventional (positive affective stimuli and reward value) or organic (integration of potentially conflicting value attributions) food.

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Competing Interests
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Authors' contribution
Experiments setup and study design: KF, EG. Performed the experiments: EG, AS. Data analysis and interpretation: FS, EG. Wrote the manuscript: KF, FS, EG. All authors read and approved the final manuscript.

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