

# Dynamics of Muslim consumers' behavior toward Halal products

## Exploration study using fMRI technology

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### Abstract

**Purpose** – Since Islamic markets are growing substantially, there is an urgent need to gain a better understanding of how Muslim consumers perceive products from a religious perspective. The purpose of this paper is to investigate the brain responses of Muslim consumers to Halal and non-Halal products using a functional magnetic resonance imaging (fMRI) technology.

**Design/methodology/approach** – The research model is a simplified version of the theory of planned behavior. The initial experiment began by asking participants to divide a set of images into two groups: Halal and non-Halal products. The fMRI experiment uses a blocked design approach to capture brain activities resulting from presenting the two groups of images to participants, and to record the strength of their attitudes toward purchasing the products.

**Findings** – Across all participants, the level of brain activation in the ventromedial prefrontal cortex increased significantly when Halal images were presented to them. The same results emerged when the Halal images showed raw and cooked meat. The variations in the results may be due to the high emotional sensitivity of Muslim consumers to using religious products.

**Research limitations/implications** – This study uses a unique approach to monitor brain activity to confirm that consumers from specific market segments respond differently to market products based on their internal beliefs. Findings from this study provide evidence that marketing managers targeting Muslim markets should consider the sensitivity of presenting products in ways that reflect religious principles, in order to gain higher acceptance in this market segment.

**Originality/value** – Although the literature reports considerable research on Muslim consumers' behavior, most of the previous studies utilize conventional data collection approaches to target broad segments of consumers by using traditional products. This paper is the first to track the reactions of the Muslim consumer segment to specific types of market products.

**Keywords** Halal products, Muslim consumers, Consumer behaviour, Islamic markets, Functional magnetic resonance imaging

**Paper type** Research paper

### Introduction

Islamic marketing is growing in importance as an independent domain of marketing inquiry, and it is in the process of constant development (Wilson and Liu, 2010; Alserhan, 2011; Arham, 2010; Sandikci, 2011). Interestingly, there has been an increase in the relevance of Islamic marketing and its applications in different aspects of business domains (Sandikci, 2011; Wilson, 2012). Over the past few decades, many researchers have explored Islamic marketing from different perspectives, including, for example, the market orientation of Islamic banks (Zebal and Saber, 2014), Islamic marketing as macromarketing



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(Kadirov, 2014), Muslim shopping behavior (Osman *et al.*, 2014) and Muslim clothing choice (Bachleda *et al.*, 2014). Therefore, this study is an attempt to take Islamic marketing one step further using a new approach to investigate Muslim consumption behavior.

One important aspect of Islamic marketing research is exploring the Halal industry in terms of its preparation, production, display, marketing and consumption (Ahmed, 2008; Ireland and Rajabzadeh, 2011; Mukhtar and Butt, 2012). This industry consists of food products, non-food products (pharmaceuticals and cosmetics), ethics (Saeed *et al.*, 2001) and services (logistics, banking and tourism). Al Jallad (2008) explained that Halal represents the Islamic way of life in that it encompasses behavior, speech, dress, conduct, manners and dietary habits. In this research context, Halal food products are defined as those permissible for use according to Islamic law (Shariah) (Lada *et al.*, 2009; Dahlan *et al.*, 2016). Worldwide, the scope of the Halal industry's business and trade is increasing in importance as it is emerges as a quality global lifestyle brand (Lada *et al.*, 2009; Hanaysha *et al.*, 2016). According to the Malaysian Investment Development Authority (MIDA, 2016), the global Halal food industry in 2013 averaged over \$1.2 trillion, and is expected to reach \$6.4 trillion by 2030.

Currently, the Halal food industry accounts for almost 12 percent of total global food products, and continued expansion is expected to create additional opportunities for the Halal industry, given that the Muslim population is projected to reach 2.2bn by 2030, up from 1.8bn in 2012 (Grim and Karim, 2011). Riaz (1999) estimated the total purchasing power of Muslims at \$12bn in the USA alone, of which \$3bn was spent on meat and poultry. The European Halal market is estimated at \$67bn, with the UK, France and Germany showing the highest demand for Halal products. These statistics demonstrate the significant potential of the Halal market worldwide, even in non-Muslim markets. Moreover, the World Islamic Economic Forum projects that Muslims will account for 30 percent of the world population by 2050 (WIEF, 2016). Thus, the resulting expansion in the global Halal market indicates the need for more research to better understand the different aspects and factors that drive this market growth, along with how Muslims and non-Muslims perceive the Halal market over time.

The objective of this study is to assess the behavior of Muslim consumers toward Halal products from a new perspective, using a functional magnetic resonance imaging (fMRI) technique to track the brain activation of participants when they are presented with images of Halal and non-Halal products. We aim to investigate whether the brains of Muslim consumers would perceive these two sets of images differently. Recent major findings in neuroscience have led to the development of a new sub-discipline called neuro-marketing. This scientific advancement can enhance our understanding of the biological component of human behavior affecting the decision-making process behind decisions of whether to purchase or use Halal products, and it could help companies to gain a deeper understanding of consumer behavior so that they may develop advertising techniques in order to attract Muslim consumers. This study is the first to apply fMRI technology to explore consumer behavior from the perspective of religious belief. As the study is multidisciplinary, every effort is made to describe the information clearly, especially the technical data.

### **Islamic markets**

With approximately 1.8bn Muslims in the world today (Pew Report, 2015), the Muslim consumer segment unquestionably represents a remarkable opportunity for businesses and marketers across the world. In fact, western companies are becoming increasingly interested in Muslim markets, and some companies that have already started to build their brands across the Islamic world are working hard to achieve inclusive global domination by expanding within the largest segment of the world's population. Reliable information about the structure of Islamic markets has recently started to appear because Muslim consumers are distributed across more than 65 countries.

The increased interest in Islamic markets research led to the establishment of the International Islamic Marketing Association, which nurtures the development of the theory and practice of marketing in the Muslim world and beyond. Since then, many journals have been established to address various issues related to Islamic marketing and how it can be useful to enhance the value of the current marketing system. The importance of adopting Islamic practices in managing different aspects of business became evident after the financial crisis in 2008, and the subsequent damage it caused to world markets.

One of the most reliable reports on Muslim consumers is the Pew Report (2009), which provides data about the behavior of Muslim consumers worldwide. This report offers a good insight into Muslim consumers in various countries to show that Muslim market segments vary according to region (Kearney, 2007). Despite such deviations in their behavior, Minkus-McKenna (2007) demonstrated that 70 percent of all Muslims worldwide choose products based on Islamic laws. Generally, Muslims look for Halal products, which are made by following Islamic principles. If the products are not compatible with Islamic principles, they are judged as non-Halal, and Muslims are not permitted to buy or use them. Halal and non-Halal terms apply to all aspects of a Muslim's life, including food and non-food items, lifestyle goods and services. Companies that produce non-Halal products and services find it difficult to market to Muslim countries. Therefore, ensuring compliance with Islamic principles is the most reliable way to ensure the acceptance of a company and its products among Muslim consumers.

The fast growth of Muslim markets is due to the high birth rate of Muslims as compared to the birth rate of western countries, which is well below the natural replacement rate. Based on this growing trend, the United Nations Population Fund estimates that Muslims will account for 30 percent of the world population by 2050. Alserhan (2010) suggested that the global Islamic market is projected to grow at 15 percent annually, making it the fastest growing market segment worldwide. A significant portion of this market increase will be in developed countries, especially in Europe, where massive immigration and a high birth rate will likely shift their market structure.

### **fMRI technology and consumer behavior**

The utilization of fMRI as a technique in the marketing domain emerged in the early 2000s, when studies began to confirm the importance of the ventromedial prefrontal cortex (vmPFC) region in human decision making (Fellows and Farah, 2005; Hsu *et al.*, 2005). Research shows that any damage to this region of the brain can reduce one's ability to make sound judgments, such as when selecting between alternatives (Fellows and Farah, 2005). From a marketing standpoint, it is vital to understand which stimulations produce more brain activity than other stimulations during the decision-making process. Constant improvements in fMRI technology and its tracking capabilities have made brain imaging more attractive for consumer researchers by expanding their comprehension of how the brain reacts to various advertisement stimuli. fMRI allows researchers to measure brain responses directly and determine the precise location of their source. Therefore, it is deemed better than standard measurement techniques, such as questionnaire surveys, because it verifies the occurrence of an internal incident at the neurological level, and yields a deeper understanding of causal processes.

Although the utilization of fMRI in the marketing domain has grown considerably in the past decade, its use is still limited among marketing and consumer behavior scholars. This restricted diffusion is due to a number of factors. First, accessing the technology involves mutual coordination with the clinical researchers who own the medical technology. Second, the cost of conducting several studies to examine a model may be too high for business funding projects. Third, since marketing investigators' knowledge of neuro-marketing methods is limited, this poses a hurdle for most of them in terms of their

ability to evaluate properly the importance of fMRI technology. Therefore, performing more consumer behavior studies utilizing fMRI technology will build solid proof of its value in explaining the process by which the human brain evaluates stimuli to reach a decision.

The fMRI technology depends on putting the participant inside a powerful magnet, where the head is placed into a radio frequency coil that submits and receives the radio waves. During an fMRI experiment, a set of stimuli (as images) are presented to participants and their brain activity is recorded. The changes in blood oxygenation in the brain that arise in response to neural activity are recorded. Generally, when certain areas of the brain become more active, it consumes more oxygen, and extra blood flows to the active area to meet this increased demand for oxygen. This variation in a specific area produces deviations in local magnetic properties, causing small alterations in the MRI signal from the blood, based on the level of oxygenation. Since blood oxygenation differs depending on the degree of neural activity, such differences can be utilized to identify brain activity in specific regions. This method of MRI is known as blood oxygenation level-dependent imaging. Based on this process, fMRI is able to produce activation maps showing which regions of the brain react to a stimulus. More information about fMRI technology can be found in the study of Huettel *et al.* (2008).

### Literature review

The decision-making process behind selecting Halal food is often shaped by dominant social norms and practices, with religion acting as a major factor in this theme. There is considerable evidence that religion can influence customer purchasing behavior in general (Delener, 1994; Pettinger *et al.*, 2004), and food selection decisions in particular (Swanson, 1996; Blackwell *et al.*, 2001). Since Halal products are proven to be healthier and taste better than their corresponding non-Halal products (Abdullah, 2007), many food companies in non-Muslim countries have approved of Halal practices in their business operations (Abdul-Talib, 2010; Wilson *et al.*, 2013). Additionally, many non-Muslim consumers believe that the Halal process of food preparation obliges business owners to follow ethical practices in their business activities (Bergeaud-Blackler, 2006), thereby forcing them to provide better quality food. Thus, Golnaz *et al.* (2010) found that the Halal logo can provide more value and is more important than ISO (or similar) certification in terms of customers' perceptions. This confirms that the Halal process emphasizes cleanliness and environmental hygiene, from planting the crops to serving the food – a notion that is widely appreciated by Muslim and non-Muslim groups.

The role of religiosity on the intention to choose Halal products has been investigated by many researchers across different countries (Mukhtar and Butt, 2012; Ahmed, 2008). Findings suggested that various factors influence the selection of Halal products by consumers, including subjective norms, attitudes and religiosity. Bonne *et al.* (2007) performed a study on Muslims living in France who were mainly of North African origin. They found that personal attitude, subjective norms and perceived control over consumption mostly explained the buyers of Halal products' intentions. Also, findings from previous research suggest that the buying behavior of consumers with high levels of religiosity differs from the behavior of those with low levels of religiosity. For example, Cleveland and Chang (2009) examined the influence of the level of religiosity on attitudes toward materialism, whereas Sood and Nasu (1995) studied the relationship between religiosity and shopping behavior. Recently, Jamal and Sharifuddin (2015) found that the level of religiosity impacts the effect of perceived value toward the intention. This study suggests that Muslims will try to identify what is Halal and what is not and consume products that match their religious values (Wilson and Liu, 2010). Alserhan (2010) examined various Islamic branding-related issues that a company has to follow in order to increase its chances of success in the Halal industry. He stressed that current sources of information in

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this field at both the academic and business level remain limited, suggesting that a reliable reference organization be established to supervise and approve correct practices in the Halal industry. He stated that more exploration of the field is needed to define the road map for future research.

Thus, it is imperative that companies understand the dynamics of Muslim consumers when marketing to countries with a Muslim population. In the past, western companies used their product and brand names to enter the global market; however, with the rapid development of Islamic countries and the ambition of Muslims in a branded world, these companies need to have a better understanding of the Islamic perspective of Muslim consumers. This issue is relevant for all companies, not just those from Muslim countries, because it enables them to act on the factors that shape the behavior of Muslim consumers (Saeed *et al.*, 2001; Rice, 1999; Wilson, 2006; Alserhan, 2015). For this reason, there is a need to understand the perception of Muslim consumers toward Halal and non-Halal products to know how companies should plan their marketing strategies effectively.

A growing interest in investigating the impact of Islamic practices on business activities has appeared in recent years, along with an interest in how they can provide essential guidance for understanding Muslim consumers (Rice, 1999; Siddiqi, 1992; Kahn, 1995). This mounting interest can be observed by tracking the interest in creating specialist journals and conferences; the increased number of organizations worldwide that certify Halal products; the augmented activities of multinational companies to expand globally in Muslim countries; the growing movement toward creating a Muslim trading block; and the financial crisis of 2008, which devastated the world markets and revealed the need for more socially responsible business practices. Consequently, more research has been conducted to explore the real value of religious practices and business marketing practices (Saeed *et al.*, 2001; Dubinsky *et al.*, 1991; Green, 1993).

From a neuroscience perspective, images are used in many fMRI studies to investigate how consumers' brains respond to various products (brands) during the decision-making process (Santos *et al.*, 2011; Yoon *et al.*, 2006). These studies have yielded important findings on the brain's reaction to brand images. For example, some studies concentrated on detecting the correlation between certain stimuli (i.e. brands) and certain activation regions in the human brain in order to understand how consumers perceive, process and make decisions about assessing different brands (Santos *et al.*, 2011; Yoon *et al.*, 2006; Paulus and Frank, 2003). Previous research indicates that fMRI is a powerful technique for studying consumer psychology related to branding, because it has high sensitivity to brain responses to stimuli (brands). Using this technique, in studying participants' brains' reactions, increased brain activation in certain regions is correlated with specific stimuli associated with a certain brand.

Increased interest in neuroimaging technology has motivated several studies to explore consumer behavior (Paulus and Frank, 2003; Schaefer *et al.*, 2006; Klucharev *et al.*, 2008). McClure *et al.* (2004) used behavioral taste tests during an fMRI experiment to investigate the brain activities that correlate with the behavioral preference for Coke or Pepsi. They discovered brain activities that consistently linked to individuals' behavioral preferences for these drinks. After investigating the impact of brand image on selecting a drink, and the associated brain activities, they concluded that brand awareness of the drink had a substantial influence on behavioral choice and the level of brain activation. Based on their findings, they suggested a basic model that links brain activities to positive behavioral preferences. Many studies have confirmed the importance of certain brain regions in the decision-making process (Fellows and Farah, 2005; Hsu *et al.*, 2005). For example, Chib *et al.* (2009) found that the vmPFC region is primarily responsible for making decisions between primarily different types of rewards. This specific region was associated with how much the individual valued each group of goods (such as food, non-food consumables and monetary rewards).

Recent studies using fMRI technology also found that specific brain regions could be responsible for specific responses. For example, Al-Kwafi (2015) investigated the influence of images of destinations on tourists' decision-making process and realized that the level of brain activation increased when participants were instructed to judge attractive destination images as compared to unattractive ones. He found that a positive attitude toward an attractive destination image contributed to a higher intention to visit that destination in the future. Another study by Al-Kwafi (2016) explored the use of fMRI technology in determining attitudes toward switching between brands of smartphone products. He noticed that there was augmented brain activation in the vmPFC when participants were asked to judge images that reflected the perceived usefulness of a brand, as compared to judging images that reflected brand pleasure.

Previous studies provide solid evidence that fMRI technology is a useful tool with which to investigate the consumer psychology behind selecting products or brands. Plassmann *et al.* (2012) confirmed this view by providing a comprehensive review of past and current studies on consumer neuroscience and its potential applications for academics and practitioners. They indicated that fMRI is used extensively as a powerful technique for studying consumer psychology related to branding because it has high sensitivity to brain responses to stimuli (brands).

Furthermore, there is strong evidence to show that the vmPFC region processes fundamental information about the comparative importance of options, thereby anticipating an explicit role for this region in explaining the decision-making behavior of an individual in selecting a specific alternative (Fellows and Farah, 2005; Santos *et al.*, 2011). Santos *et al.* (2012) explored the neural correlates of brand perception, where preferred brands activated regions of the brain that were expected to be emotional inducers. They found that brands rated as positive activated the ventral medial frontal pole, which may be assigned to self-relatedness and to the role of brands in self-construal. Additionally, they found that the participation of the emotional system was significant, where every brand was felt in order to be evaluated. The study findings supported previous research that had explored the influence of the human emotional system on modulating the processing of brand perception (Paulus and Frank, 2003). Other studies have also indicated the contribution of the human emotional system to certain car brand logos (Schaefer and Rotte, 2007) and brands of chocolate bars (Koenke *et al.*, 2008). To support previous research findings, Deppe *et al.* (2005) suggested that vmPFC is central in the processing of emotions during consumer decision making when evaluating brands.

Reimann *et al.* (2011) assessed numerous studies that utilize fMRI to study consumer behavior, with many of them suggesting a positive association between brain activation and positive attitudes toward selecting a brand preference. Venkatraman *et al.* (2012) prepared a research schema, incorporating fMRI technology to implement market segmentation, based on separating the fMRI results into specific groups with different needs. These findings provide marketing managers with a better understanding of the factors that underpin consumer selection of their products and of the best marketing strategies to increase consumer attention to specific products (Klucharev *et al.*, 2008).

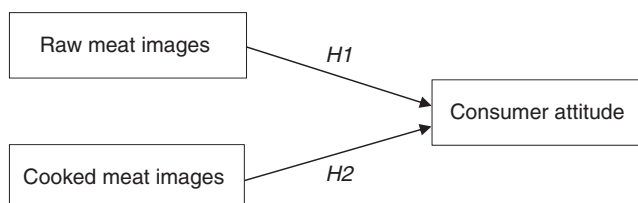
The main objective of this study is to propose a new avenue of research that investigates the cognitive reaction of Muslim consumers to Halal and non-Halal product images using fMRI technology. This exploratory study is the first attempt to track consumers' brain responses to such kinds of products. Although research of this nature has never before been implemented in Islamic marketing research, it has critical implications for practice and theory. In this paper, the theory and proposed hypotheses are developed, the methodology design is drafted and the research outcome is discussed, along with its potential implications. Future research directions are highlighted to define promising areas for further exploration.

### Theoretical framework and research hypotheses

Consumer attitudes include cognitive, affective and behavioral components (Solomon *et al.*, 2006). The cognitive part is the assessment made in establishing an attitude by considering knowledge and beliefs about a product (brand), the affective part is a psychological response reflecting the feelings of the consumer toward a product, and the behavioral part is the physical indication of the consumer's intention to select a product. The theory of planned behavior (TPB) (Ajzen, 1985) has often been used in Muslim and non-Muslim countries to measure the intention to consume Halal products (Alam and Sayuti, 2011; Khalek and Ismail, 2015; Ho *et al.*, 2008). Ajzen (1991) depicted attitude as psychological tendencies causing an individual to act in a specific manner after assessing a particular behavior. In this paper, the TPB is adopted as a foundation to explain the influence of Halal and non-Halal images on consumer attitudes, which impacts behavioral intention during the decision-making process to select a specific product. Figure 1 presents the proposed model, which is a simplified version of the TPB. This model was selected as it is more practical for justifying the use of fMRI experiments, which is highly sensitive to complex models, causing more conflicts in interpreting findings (Amaro and Barker, 2006).

Bruce *et al.* (2012) explored the influence of food advertisements on manipulating choices in children. They found that food logos increased activation in the orbitofrontal cortex and inferior prefrontal cortex, which confirmed that food images activate some brain regions in children that are known to be associated with motivation. Another study by Evero (2011) to determine brain responses to visual food cues of different energy value during an fMRI found greater activation in the food reward region (medial orbitofrontal cortex). Halal products are distinguished by special labels (or by their overall appearance) to indicate that they were processed in a special way in accordance with Islamic law (Akhtar *et al.*, 2017; Abedifar *et al.*, 2015). Using different languages and symbols, such labels are adopted worldwide. Previous studies assessed the influence of Halal products on consumer purchasing behavior using direct marketing surveys only (Ahmed, 2008; Bonne *et al.*, 2007).

However, in this study, images of Halal and non-Halal products will be presented during fMRI imaging sessions to monitor consumers' brain responses, and to record their attitudes. The positive influence of Halal images on consumers' attitudes is expected to affect their decision making behind selecting those products, as they comply with their beliefs. Since the assessment of product images has an emotional component, in terms of generating feelings toward the images, certain regions of the brain are expected to experience increased activation throughout the decision-making process (Tom *et al.*, 2007). Thus, attitude can be assumed to be a psychological tendency to favor or disfavor a product image (Birgelen *et al.*, 2003). Moreover, the vmPFC is expected to experience increased activation during the decision-making process behind selecting Halal products (Tom *et al.*, 2007). This emotional component could be the result of Muslim consumers' belief that choosing this product is the right decision to make. The increase in brain activation could be a direct effect of Halal images being emotionally appealing to consumers because Halal indicates that Islamic laws were followed in a product's preparation. This attitude is expected to hold true whether the meat product is cooked or uncooked. We intentionally selected these two conditions for the



**Figure 1.**  
The proposed  
research model

meat in order to find out if the human brain reacted differently in both conditions. For example, non-Halal cooked meat is ready for direct consumption, and its compliance with Islamic law is determined immediately, so Muslims might feel uncomfortable. By contrast, non-Halal raw meat still requires more processing before it can be consumed, so the obedience to Islamic values has some room for evaluation and deciding. Based on this argument, the following hypotheses are proposed:

- H1. The more attractive the raw meat images (as being Halal), the greater will be the activation of the vmPFC in making a decision to select this product.
- H2. The more attractive the cooked meat images (as being Halal), the greater will be the activation of the vmPFC in making a decision to select this product.

### Research methodology

Previous research has treated images as a construct with two evaluation components: cognitive and affective. However, it was found that the overall image is more likely to be influenced by affect than by cognitive evaluations (Baloglu and McCleary, 1999), whereas emotion might play a considerable role in a consumer making the decision to select a Halal product based on their overall assessment of the image. The emotional model of advertising can lead to greater emotional responses by consumers and more effective decision making (Wood, 2012). Since level of religiosity and spirituality can impact the decisions of individuals (Jamal and Sharifuddin, 2015; Krägeloh *et al.*, 2012), we intended to select study participants from moderate Muslims who practice their religious beliefs in a balanced way. This means that participants rate religion as an important part of their lives but do not consider themselves strict Muslims. Level of religiosity was assessed by a short survey that links participants' daily practices with Islamic teachings (Pew Report, 2008).

In this study, the Halal product images for the fMRI experiment were selected from common advertised products. The study is conducted using the fMRI experiment. The following sections describe the steps required to perform this experiment. Since this experiment involves complex procedures to measure brain signals, and complex approaches to analyze images to generate the ultimate findings, the information will be presented in a simple format so that researchers can have a clear understanding of the study's structure.

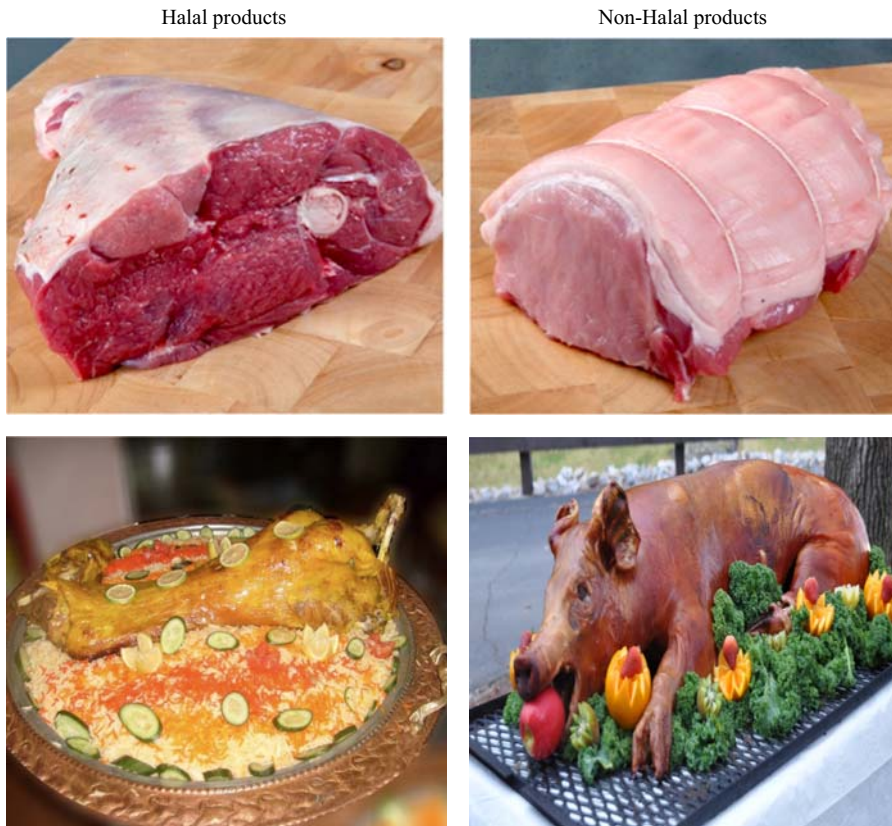
#### *Pre-experiment preparation*

This preparation session was important to define the Halal product images (stimuli) to be used in the fMRI experiment. In this stage, several participants attended a focus group session. Sets of images of different market products were collected by the study's administrators. These images represent different types of Halal and non-Halal products that can be found in a supermarket. Participants were asked to divide these product images into Halal and non-Halal products based on their ability to differentiate them in an obvious manner. The final set of images represents the independent variable that will be used during the fMRI imaging session. Figure 2 shows an example of the Halal and non-Halal product images that represent two levels of the independent variable, where the top row represent products before cooking (raw products) and the bottom row shows meat products after cooking. These images were used as stimuli during the fMRI experiment to track brain responses to each variable.

#### *Experiment design*

A block design was used to control the fMRI experiment, in order to maintain cognitive engagement during the sequential presentation of stimuli within a condition



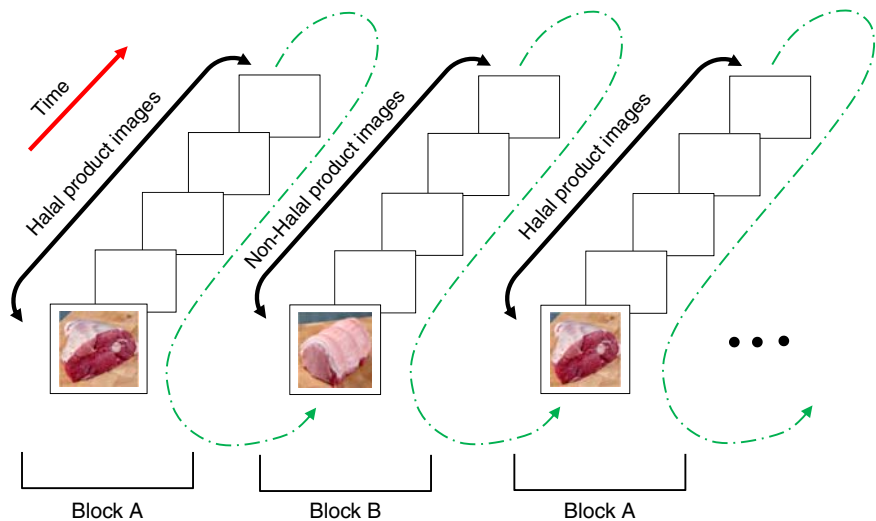


**Figure 2.**  
A sample of the  
halal and non-halal  
product images

(Amaro and Barker, 2006). In general, a block design offers high statistical power (Friston *et al.*, 1999) and creates a relatively strong change in brain signal related to the baseline acquisition (Buxton *et al.*, 1998). Figure 3 shows the proposed block design for the fMRI experiment, with two blocks being used. Block A contains a group of images of Halal products, and Block B contains a group of images of non-Halal products; both sets of images were defined in the pre-experiment session. The MRI scanner used for the functional imaging was a 3 Tesla Siemens MAGNETOM Skyra. The scanning session was divided into multiple runs, and each run contained 17 blocks; 8 blocks encompassed meat pictures, while a crosshair display was used as a rest. Each of the blocks was 15 s long, and they were arranged in an interleaving pattern starting with a rest condition, followed by one of the picture blocks, and so on. The subjects were asked to silently evaluate the presented picture. The functional scans consisted of 85 volumes (repetition time 3,000 ms; echo time 30 ms; flip angle 90°; 36 axial slices; matrix 94×94).

#### *Pilot testing*

It is important to pre-test the experimental design on volunteers in order to ensure the appropriate timing of the pulse sequence and the ability to generate high-quality images. In the pre-test stage, it was vital to check that the images of each block were presented in the correct order, to avoid cross-signal variations from different types of stimuli. In addition, participants should be educated about the fMRI imaging session and



**Figure 3.**  
The proposed block design that controls the fMRI experiment

the kinds of images they would see while lying inside the scanner. More detailed information on the concept of the fMRI process can be found in the studies of Buxton (2002) and Huettel *et al.* (2008).

#### *Imaging session*

Ten participants were able to participate in the actual fMRI experiment. The demographic variables relating to age and education were collected. All participants were Muslims between the age of 20 and 31 with an average education duration of 14.1 years. During the actual fMRI scan, participants lie motionless on a bed in the MRI scanner for approximately 60 min. The first 10 min were used to acquire images of the brain anatomy, which are used to determine the areas of the brain where fMRI data are obtained. Next, the actual fMRI experiment was run according to the block design described above. During the experiment, participants sequentially see two groups of stimuli (Halal and non-Halal) through a special projection device. While viewing the images, participants were asked to think about their attitude toward eating the meat presented. The baseline data were collected during the resting state when no stimulus was presented (Gusnard *et al.*, 2001). After completing the imaging session, each participant completed a short survey to collect extra information about their background and attitude toward the presented images.

#### *fMRI image analysis*

The final results can be obtained from the collected images after performing a series of image-processing procedures. Detailed information about these standard image-processing techniques can be found in these references. Data analyses were carried out using FEAT, from FMRIB's Software Library (FSL version 5.9; [www.fmrib.ox.ac.uk/fsl](http://www.fmrib.ox.ac.uk/fsl)). Pre-processing consisted of motion correction, removal of non-brain tissue, spatial smoothing using a 5 mm full-width-at-half-maximum Gaussian kernel (Huettel *et al.*, 2008; Brett *et al.*, 2002), and high-pass temporal filtering equivalent to 100 s (0.01 Hz). After pre-processing, the fMRI volumes were registered to standard-space (MNI152) images using nonlinear registration. Then, a paired *t*-test was conducted to showcase the distinct areas of activation associated with each category based on the Harvard-Oxford

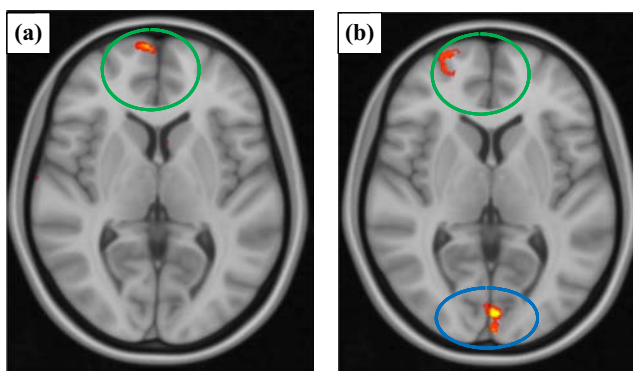
cortical and subcortical structural atlas. Final results are presented in color on the anatomical brain images in order to facilitate the visualization of the brain regions with significant activation levels.

### Results and discussion

To show the brain activities that took place during the fMRI experiment, Figure 4 demonstrates axial brain images taken of the same participant. These images illustrate the brain region that exhibited a significant difference between Halal and non-Halal images (marked in colored circles). For example, Figure 4(a) shows the significant difference in brain activations when the participant was presented with Halal and non-Halal raw meat during the fMRI experiment. Similarly, Figure 4(b) indicates the significant difference in brain activations when the participant was presented with the Halal and non-Halal cooked meat. In both cases, there are significant brain variations when different group of images were presented to the participants during the fMRI experiment.

Figure 4 shows that the vmPFC region exhibited increased activation in both cases (marked by green circles). This region was frequently found in previous research to be responsible for decision-making processes (Fellows and Farah, 2005; Hsu *et al.*, 2005) because it performs basic information processing about the relative importance of alternatives, indicating it plays an explicit role in consumer behavior when making decisions to select products. Since the process of selecting Halal products includes a risk component related to obeying Islamic law, the vmPFC region shows more activation for Muslim participants when deciding between Halal and non-Halal products. A similar finding was made by Tom *et al.* (2007), in that the vmPFC region shows more activation while assessing potential risk during decision making. On the other hand, Reimann and Bechara (2010) showed that emotion plays a considerable role in decision making and that it increases brain activation in the vmPFC. This could be applied to our case as Muslims are emotionally attached to their religious beliefs, and they aim to implement them in real life, which can explain the increased activation in the vmPFC region.

In the presentation of Halal and non-Halal cooked meat images, extra activation was noticed in the occipital lobe (marked by the blue circle), which is responsible for visual processing. The increased activation for the cooked meat could be explained by the notion that the food is ready for consumption, which means that a specific decision has to be made with regard to whether it is permitted or not, which in turn requires extra visual focus to determine its compliance with Islamic tenets. Previous research showed that focusing on different components of a picture can cause increased activation in this region of the brain (Lafer-Sousa *et al.*, 2012; Clark *et al.*, 1997).



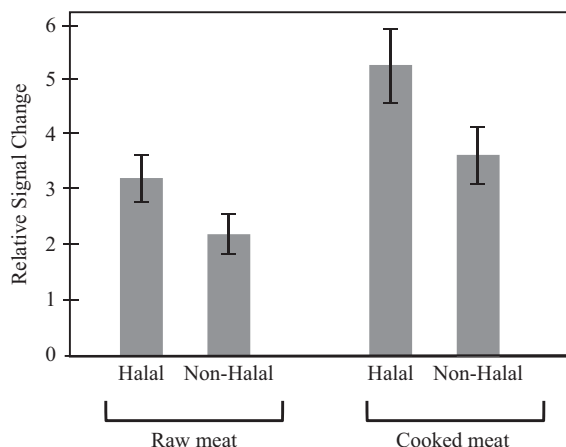
**Figure 4.**  
Neural responses  
during decision  
making to select  
a product

Figure 5 demonstrates the level of change in brain activation across all participants relative to the baseline, or while at rest when no images were presented during the fMRI experiment. The values presented in Figure 5 were calculated by measuring brain signal intensity in Figure 4, by analyzing the region of interest (green circles) in the analysis software. In the raw meat case (independent variable), the vmPFC's activation while making the decision of whether to select Halal meat images was significantly higher than the corresponding activation produced from non-Halal images ( $p < 0.05$ ). This supports *H1* and confirms previous findings that identify the vmPFC as a region for processing a selection decision (Engelmann *et al.*, 2009; Fellows and Farah, 2007). From the same figure, we observe greater brain activation in the vmPFC area during consumer attitude toward selecting Halal cooked meat as compared to non-Halal cooked meat; this variation in signal intensity is also significant ( $p < 0.05$ ). This outcome supports *H2* and endorses previous findings that participants' brain activations increase toward the positive images that they would like to select, and which reflect their internal beliefs and values (Al-Kwafi, 2015). From this study, it seems that participants were more focused and concentrated on selecting a product that matched their religious principles, which could be linked directly to their attention to think before deciding on the presented images – especially because some of the images contained food that is prohibited from consumption according to Shariah law.

Precisely how the brain evaluates the images presented during an fMRI experiment to determine which reflect a person's internal beliefs is not understood. Nonetheless, behavioral attitude was used in this study (and in previous studies) during the pre-experiment preparation to determine the images that were deemed to be compliant with the participants' beliefs; then, the fMRI experiment was used to monitor brain activation and examine the participants' selections. To have an in-depth understanding of the mechanism by which consumers weigh the subjective relative value of current alternatives, and use previous information as a reference point, requires a more sophisticated model to consider additional factors, which is beyond the scope of this study.

### Implications

This study provides a new body of evidence to show that Muslim consumers are inclined to follow special rules regarding consumption based on Islamic law. Unlike other studies that have used conventional approaches to study consumer behavior, this study used – for the first time – an fMRI technology to explore Muslim consumers' attitudes toward Halal products.



**Figure 5.**  
Level of change  
of each variable  
relative to baseline

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The findings significantly contribute to the existing consumer behavior literature by tracking brain activities during decision making to select a product, and define the conditions that cause more activations in favor of a specific product. This is critical to gain a better understanding of the underlying mechanisms and related factors when consumers are exposed to different advertisement strategies (Al-Kwafi, 2015). Using a neuroscience experiment, this exploratory research determined the brain region that influences a Muslim consumer's decision to select a Halal product. This can be used as a foundation to explore brain responses to other products and brands in order to yield new insights into and knowledge of the functionality of Muslim consumers' behavior and how it can be evaluated for various types of products and brands (McClure *et al.*, 2004; Paulus and Frank, 2003; Schaefer *et al.*, 2006).

In the literature, the perceived behavioral control refers to consumers' perceptions of their ability to perform a given behavior. It is assumed that perceived behavioral control is determined by the total set of accessible control beliefs (Ahmed, 2016), or that it indicates the perceived availability of the required resources and opportunities. Therefore, the perceived behavioral control was represented by some measurable factors to assess its influence, such as switching costs (Burnham *et al.*, 2003; Heide and Weiss, 1995), procedural switching costs (Guiltinan, 1989) and personal relationship costs (Aaker, 1992). In this study, the perceived behavioral control was symbolized by the internal belief that religious values have to be followed, which prevented Muslims from buying any product that did not comply with their belief. On the other hand, findings from previous research suggest that the human emotional system analytically moderates the process of selecting a brand preference (Paulus and Frank, 2003; Schaefer *et al.*, 2006; Koeneke *et al.*, 2008). These findings support the notion that Muslim consumers' behavior is based on emotion, leading them to select a Halal product because they are psychologically attached to their beliefs and vigilant about following particular rules (Saeed *et al.*, 2001).

Since Islamic markets are substantial and continue to expand across the world, the current findings can guide managers of various food and cosmetics companies to have a better understanding of this market segment's consumers. Such knowledge would enhance their advertisement and promotion strategies and make them highly effective in influencing the purchasing decisions of Muslim consumers (Alserhan, 2015; Wilson and Grant, 2013; Wilson and Liu, 2011). Muslims are not concentrated in one region; they are distributed globally and have significant presence in all countries. However, some companies, such as the Nestlé Company, have been able to tailor their advertisements for specific regions and issue an annual list of the Halal products they produce. From a practical standpoint, this study presents new evidence for marketing managers to show that Muslim consumers react differently toward Halal and non-Halal products, and that their selection of such products is directed by a cognitive process that leads them to prefer what is assumed to be permitted by their faith. This evidence could be used as motivation to present Halal products in separate sections, as some retailers are doing now, in order to increase consumer confidence and allow them to make their purchase without hesitation or feeling like they need additional verification, since they will recognize the product's location as indicative of it meeting their specific requirements.

In summary, this study provides a new approach to explore and evaluate the behavior of Muslim consumers toward Halal products, allowing us to track the brain activation of participants when they are presented with images of Halal and non-Halal products. Study findings show that Muslim consumers present different cognitive reactions toward Halal and non-Halal products, even without having them labeled with Halal logos, emphasizing that Muslims are concerned with following their religious beliefs. Thus, this market segment has to be treated differently by companies by following proper marketing and advertisement strategies.

### Limitations and future research

The study considers specific kinds of food as an example of Halal products; however, the same fMRI experiment can be repeated for a variety of Halal consumer goods and services, such as Islamic banking and investment, Islamic clothing and cosmetics, among others, to produce interesting comparisons. Such extended research could lead to the creation of a cognitive brain map of consumers of Halal products. The outcome of this research might support the establishment of Islamic marketing theory, which could be an extension of the TPB. The new theory could show that Muslim consumers differ in making decisions when selecting products to purchase; based on their beliefs at the time they make such decisions. There is mounting evidence that supports the unique purchasing behavior of Muslim consumers; for example, Alam *et al.* (2011) found that religious Muslim consumers are more moderate in their spending habits, as demanded by Islamic law. Also, it was found that religiosity has an impact on forecasting retail patronage activities (Mokhlis, 2006). These results confirm the existence of a relationship between religiosity and the purchasing behavior of Muslims.

This research presents a basic framework for using fMRI technology to investigate Muslim consumer attitudes toward Halal products. It would be useful to increase the complexity of the model and study the impact of other variables, such as including a Halal logo or symbol, to study their impact on the decision to adopt a product. Previous research using fMRI technology has suggested that logos are much more than they appear; they are meaningful icons (Santos *et al.*, 2012; Elliott, 1994). Therefore, the appearance of Halal logos on products might encourage Muslim consumers to accept the products, since they have already passed a religious assessment by an independent agency, meaning that the individual has no need to verify their religious compliance. Another variable that can be tested in future experiments is the placement of Halal meat products in close proximity to non-Halal products (side by side), and then monitor Muslim consumers' brain activities when they are asked about their intention to buy a Halal product. Muslims believe that Halal products should not touch any non-Halal products, because if they do, they become unusable under Islamic law. It would be interesting to monitor human brain responses in this context and link them to intention.

Understanding purchasing and consumption behavior is a key challenge for marketing managers. Consumer behavior, in the broadest sense, is concerned with understanding both how purchase decisions are made and how products or services are consumed or experienced. The decision model assumes that purchase decisions do not occur in a vacuum. Rather, they occur in real time and are affected by other stimuli, including external environmental stimuli and the consumer's immediate situation. Therefore, adopting a comprehensive model in future research to evaluate consumer behavior toward adopting a particular product would help managers to gain better understanding to control this behavior and influence it, in order to increase the probability of consumers purchasing that product.

Future studies could consider including Kosher products (adhering to Jewish religious beliefs) as they are widely known in the market. Such products can be tested by using two sets of participants – Muslims and Jews – to compare human brain responses in both spiritual groups. Muslims are widely known to accept Kosher products, as they are produced using similar religious approaches; thus, the human response to Halal and Kosher products is expected to be similar, to a large extent. One of the limitations of this study is that it only considered Muslim consumers, whereas future explorations might try to find and explain potential variations between Muslim and non-Muslim consumers when they are exposed to Halal and non-Halal products. Such studies could provide new insights to understand the variations across different religious groups, and how diverse consumers' process information related to internal beliefs.

An important point to make is that fMRI brain images do not represent the actual images of the brain in action. Instead, these images show the results of complex statistical comparisons between the brain's metabolic activities during exposure to stimuli. It is not feasible to conduct an fMRI experiment that yields an instant measurement of brain activation during a given task. Therefore, combining fMRI with electroencephalogram (EEG) can provide more solid results, because EEG records brainwave activity, thereby creating a brain map that shows the electrical activity in the cerebral cortex. Combining the results of fMRI and EEG studies can produce high-quality spatial and temporal data that give significant insight into brain function during decision making to select a particular product.

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