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Demystifying neuromarketing

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ABSTRACT

This article adopts an integrated knowledge inquiry approach and systematically reviews (through content analysis) and draws themes (through thematic analysis) to explain the concept of, methods for, ethical issues related to, and contributions from neuromarketing and to discuss the future role of neuromarketing as a provider of new impetuses for advancing marketing science. In doing so, this article clarifies the key questions about neuromarketing and identifies multiple avenues to meaningfully extend existing lines of inquiry on neuromarketing. Thus, this article should assist neuromarketers in unlocking the potential of neuromarketing to contribute to marketing theory and practice.

1. Introduction

Neuromarketing is a popular topic and area of research in marketing science. In essence, the goal of neuromarketing is to adapt theories and methods from neuroscience and combine them with theories and methods from marketing and related disciplines, such as economics and psychology, to develop neuroscientifically sound explanations of the impact of marketing on target customer behavior. Indeed, neuromarketing, as a method of investigation, is important because it uses neuroscientific theories and methods to gain access to otherwise hidden information. Such information materializes through the observation of neural processes without asking people directly for their thoughts, feelings, memories, evaluations, or decision-making strategies. The outcome of neuromarketing, as a field of research, is promising as its findings can secure new ground for generating new marketing theories or supplementing existing theories in marketing and related disciplines.

Many neuromarketing scholars have published conceptual (e.g., Butler, 2008; Garcia & Saad, 2008; Lee, Broderick, & Chamberlain, 2007) and review (e.g., Cruz, Medeiros, Hermes, Marcon, & Marcon, 2016; Fortunato, Giraldi, & de Oliveira, 2014; Plassmann, Ramsøy, & Milosavljevic, 2012; Schneider & Woolgar, 2012) articles in the area. However, few studies have rigorously produced empirical findings on the topic (e.g., Costa, de Freitas, & Paiva, 2015; Jai, O'Boyle, & Fang, 2014; Stoll, Baecke, & Kenning, 2008; Vance & Virtue, 2011), and even fewer have appeared in the main academic outlets for marketing science (e.g., *Journal of Marketing*, *Journal of Marketing Research*, *Marketing Science*). This situation may be due to uncertainties associated with neuromarketing, such as the academic efficacy of neuroscience measurement techniques in advancing marketing theory, the ethical concerns with using such techniques, and the practical utility of such techniques as effective tools for marketing practice (Ariely & Berns, 2010; Arussy, 2009; Murphy, Illes, & Reiner, 2008).

In addition, neuroscience, in general, can be intimidating to both established and new marketing researchers, who may develop a piecemeal understanding of neuroscientific methods by associating neuroscience with brain imaging only (Lee et al., 2007); however, this does not need to be the case, as this article aims to show. More important, many scholars have called for greater programmatic and integrative research in neuromarketing for its study to emerge as a full-fledged area of marketing science, especially in mainstream marketing journals (e.g., Breiter et al., 2015; Lee, Chamberlain, & Brandes, 2018; Smidts et al., 2014). This is especially important given the powerful role of neuromarketing literature in educating marketing researchers, who may lack training opportunities of the type typically provided in undergraduate and postgraduate neuroscience degrees, and in driving future research in the field beyond the circle of experienced marketing scholars.[1] Thus, there is a need to demystify neuromarketing and to stimulate greater interest in actionable neuromarketing research, especially in academic outlets dedicated to the advancement of marketing science (Daugherty, Hoffman, & Kennedy, 2016; Daugherty & Thomas, 2016; Lee et al., 2018).

Given the identified gaps, this article aims to (1) demystify neuromarketing by explaining the concept of, methods for, ethical issues related to, and contributions from neuromarketing and (2) stimulate greater interest and research in the area by discussing the future role of neuromarketing and the new impetuses that it can offer for marketing

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[1] For example, Ale Smidts, Carl Marci, Carl Senior, Carolyn Yoon, Douglas Fugate, Hilke Plassmann, Martin Reimann, Nick Lee, Laura Chamberlain, Leif Brandes, Peter Kenning, Richard Silberstein, Rumen Pozharliev, Selena Nemorin, Terry Daugherty, Thomas Zoëga Ramsøy, and Vinod Venkatraman, to name a few.

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theory and practice. In particular, this article adopts an integrated knowledge inquiry approach—that is, creation of essential questions about a topic and exploration of their solutions (Lim, 2016)—as a new mode of thinking to solve the uncertainties associated with neuromarketing. Moreover, this article aims to answer the call of Lee et al. (2018) and Levallois, Clithero, Wouters, Smidts, and Huettel (2012) for research to help clarify the concept of, methods for, and ethical issues related to neuromarketing, so as to substantially increase the potential for growth in neuromarketing research and facilitate greater acceptance and visibility of the field. Finally, this article also extends Lee et al.'s (2018) quantitative work in providing an agenda for future neuromarketing research, specifically by mapping the current state of and contributions from extant neuromarketing literature, with a specific focus on mainstream marketing journals, and by identifying potentially fruitful directions for further neuromarketing research from a mixed methods approach in the form of quantitative content and qualitative thematic analyses.

2. What is neuromarketing?

Neuromarketing is an interdisciplinary product of neuroscience and marketing. The concept was first coined and referred to by Ale Smidts in 2002 as "the study of the cerebral mechanism to understand consumer behavior in order to improve marketing strategies" (Boricean, 2009, p. 119).

However, in the ensuing decade, multiple definitions of neuromarketing developed. More specifically, some scholars viewed neuromarketing as "the application of neuroscientific methods to analyze and understand human behavior in relation to markets and marketing exchanges" (Lee et al., 2007, p. 200), while others characterized it as "a field that focuses on the marketing implications from understanding the interaction of cognitions and emotions in human behavior based on neuroscientific methods" (Javor, Koller, Lee, Chamberlain, & Ransmayr, 2013, p. 3), "an extension of traditional marketing methods that seeks a deeper level of manipulation based on instinctive responses" (Nemorin, 2017), "the intersection of consumer behavior and cognitive neuroscience" (Garcia & Saad, 2008, p. 398), "the application of findings from consumer neuroscience within the scope of managerial practice" (Hubert & Kenning, 2008, p. 274), and "the study of the cortical substrates of social influence in an applied setting" (Senior & Lee, 2008, p. 264).

In addition, neuromarketing, which encapsulates the commercial (e.g., retail marketing) and non-commercial (e.g., social marketing) use of neuroscientific theories and methods to gain consumer insights and marketing effects (Ramsøy, 2015), should be distinguished from closely related concepts, such as consumer neuroscience, which pertains to the academic exercise of using neuroscientific theories and methods to enrich understanding of consumer psychology and behavior (Plassmann, Venkatraman, Huettel, & Yoon, 2015), and neuroeconomics, which refers to the sensemaking of economic problems through the analysis of neural correlates of decision making of the type studied in behavioral economics (Nemorin & Gandy, 2017). Nonetheless, neuromarketing is similar to consumer neuroscience and neuroeconomics in that it is a form of non-clinical research that studies subjects in healthy populations, as opposed to neurology, which is a form of clinical research that studies subjects in populations with nervous system disorders (e.g., injuries, traumas, tumors), and neuroscience, which studies myriad species ranging from the primitive (e.g., leeches, jellyfish) to the complex (e.g., mammals, primates) (Plassmann et al., 2012).

More important, concepts (e.g., consciousness, memory, long-term potentiation) and theories (e.g., Bayesian free energy principle, Hebbian theory, Schultz theory, theory of spatial memory) from neuroscience can be supplemented with marketing theories to support and enrich neuromarketing interpretations (see Craver, 2002; Friston, 2009; Hebb, 1949; Knill & Pouget, 2004; Schultz, Tremblay, & Hollerman, 2000). These concepts and theories can also be tested using traditional, non-neuroscientific methods often employed in marketing to gain insights into how marketing can help explain unknown states of the world causing sensory movements and reactions in the brain; it should be noted, however, that the contributions from such investigations may only be novel for neuroscience rather than for marketing (or neuromarketing) (see Arbib, 2003). Following these leads, neuromarketing can be defined more comprehensively as follows:

> Neuromarketing is an interdisciplinary branch of knowledge that is predicated on the use of neuroscientific concepts, theories, and methods (or tools and techniques to record brain and neural activity during behavior) to study the brain and nervous system in the pursuit of understanding instinctive (or natural) human behavior, in terms of cognitions and emotions, conscious and unconscious, in response to a marketing stimulus (e.g., markets, marketing exchanges), whereby the knowledge resulting from a neuromarketing investigation contributes to the development and advancement of marketing theory and the planning and implementation of marketing strategies, with (e.g., to make a sale) and without (e.g., to influence behavior for a social good) commercial marketing goals.

Such a definition has five main upshots. First, it clarifies the nature of knowledge relied on and developed in neuromarketing—i.e., interdisciplinary. Second, it explains the type of methods used in neuromarketing—i.e., neuroscientific methods. Third, it elucidates the outputs of using those methods—i.e., studies on the brain and nervous system. Fourth, it makes clear the outcomes of those outputs—i.e., understanding of instinctive human behavior in applied marketing settings. Fifth, it delineates the impacts of those outcomes—i.e., conceptual and managerial implications for marketing theory and for planning and implementation of marketing strategies.

3. What neuroscientific methods exist for neuromarketing?

Neuroscientific methods encapsulate the use of tools and techniques to measure, map, and record brain and neural activity during behavior and, in doing so, generate neurological representations of that activity for understanding specific responses in the brain and nervous system as a result of exposure to a stimulus. These methods, which allow neuroscientists to observe in real time the neural processes that occur during behavior, can be classified into three broad categories: neuroscientific tools and techniques that record neural activity inside (electromagnetic and metabolic) and outside the brain, and neuroscientific methods to manipulate neural activity (see Fig. 1). What follows in the next sections are brief summaries of the most pertinent neuroscientific methods recommended for neuromarketing. For additional readings on these methods, see Bercea (2012), Kable (2011), Morin (2011), Plassmann, Ambler, Braeutigam, and Kenning (2007), Ramsøy (2015), and Zurawicki (2010).

3.1. Neuroscientific methods that record neural activity inside the brain

3.1.1. Electromagnetic: electroencephalography

Electroencephalography (EEG) tests and records electrical activity in the brain using a band or helmet with small, electrodes placed onto the scalp of the test subject (Kable, 2011; Reimann, Schilke, Weber, Neuhaus, & Zaichkowsky, 2011; Solnais, Andreu-Perez, Sanchez-Fernandez, & Andreu-Abela, 2013). It is a non-invasive method that detects the changes in electric currents in the form of brainwaves, which are produced and recorded when test subjects are exposed to a marketing stimulus (Morin, 2011; Plassmann et al., 2007). More important, EEG offers neuroscientists in marketing the benefit of high temporal resolution for the detection of brief changes in brain activity at relatively low costs and thus helps them assess the value of a marketing stimulus (Morin, 2011). In addition, the design of EEG is portable, and thus it can be employed in real-life marketing environments (Bercea, 2012). However, the spatial resolution produced by EEG is

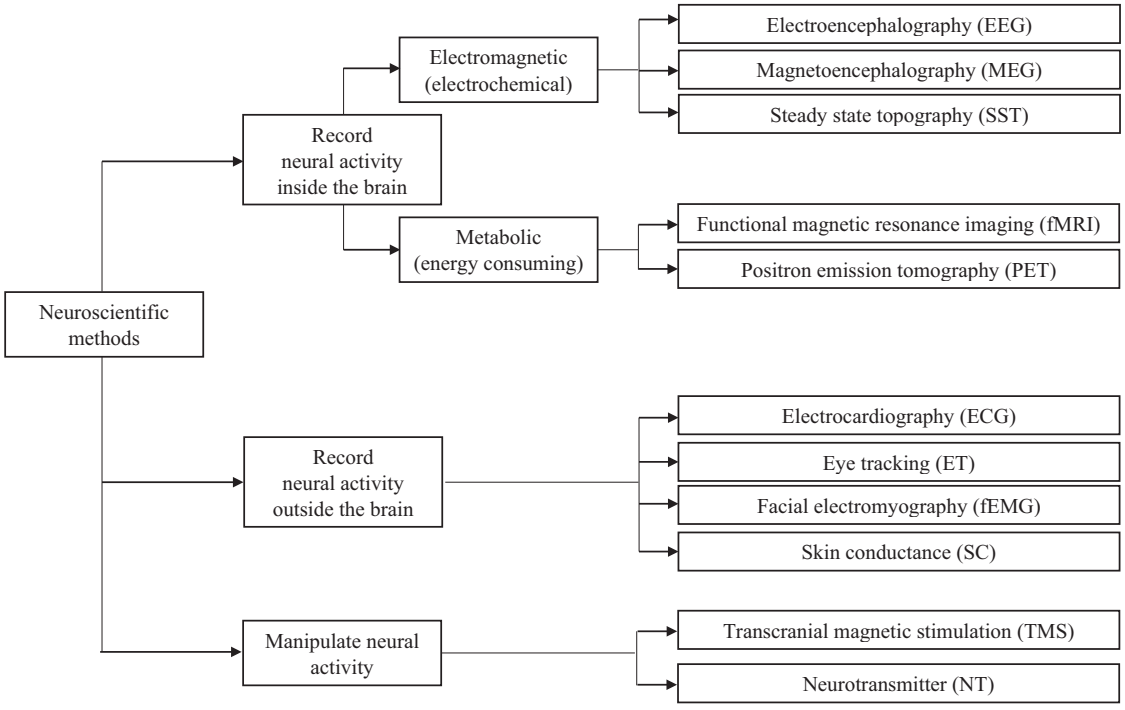

Fig. 1. Common neuroscientific methods for neuromarketing.

generally poor (Kenning & Linzmajer, 2011), thus limiting the recording of brain activity in small subcortical areas, such as the amygdala (Plassmann, Yoon, Feinberg, & Shiv, 2011), and, in turn, understanding of the cognitive process responsible for triggering activity in the entire brain (Morin, 2011).

3.1.2. Electromagnetic: magnetoencephalography

Magnetoencephalography (MEG) tests and records magnetic activity in the brain using a helmet with more than 100 and up to 300 sensitive superconducting quantum interference detectors that is placed on the test subject's head (Ariely & Berns, 2010; Kenning & Plassmann, 2005; Solnais et al., 2013). It is a non-invasive method that detects the changes in magnetic fields induced by electrical brain activity when test subjects are exposed to a marketing stimulus (Morin, 2011; Plassmann et al., 2007). More important, MEG offers the advantage of excellent temporal resolution for detecting brief changes in brain activity and thus contributes to the assessment of the value of a marketing stimulus (Bercea, 2012; Morin, 2011). However, the setup costs for MEG is more expensive than EEG (Ariely & Berns, 2010; Plassmann et al., 2011). MEG is also not portable, and thus marketing situations can only be simulated in a laboratory setting rather than in an actual marketplace setting. Nonetheless, the spatial resolution produced by MEG is superior to EEG because the magnetic field is less distorted by the skull than is the electric field and thus enables imaging of deeper brain structures (Ariely & Berns, 2010; Kenning & Linzmajer, 2011). However, its spatial resolution remains relatively limited (Morin, 2011).

3.1.3. Electromagnetic: steady-state topography

Steady-state topography (SST) tests and records brain electrical activity using a band or helmet with 64 electrodes that is placed onto the scalp of test subjects while they view audio-visual material and perform a psychological task with a sinusoidal visual flicker presented in the visual periphery to elicit an oscillatory brain electrical response in the form of steady-state visually evoked potential (SSVEP; Regan, 1989; Silberstein, 1992, 1995; Vialatte, Maurice, Dauwels, & Cichocki, 2010). It is a non-invasive method that detects task-related changes in brain activity with SSVEP measurements (Silberstein, 1992, 1995; Silberstein et al., 1990). SST measures the variations in the phase difference between SSVEP and the marketing stimulus, whereby a latency reduction indicates an increase in synaptic excitation (Silberstein & Nield, 2008; Smith & Gevins, 2004). More important, SST offers neuroscientists the benefits of a high temporal resolution as well as the opportunity to continuously track rapid changes in brain activity with high tolerance of noise and physical interference over extended periods of time, and thus it offers unique insights into brain activity based on neural processing speed (Gray, Kemp, Silberstein, & Nathan, 2003; Silberstein, 1995). However, SST is bounded by limited spatial resolution (Bercea, 2012).

3.1.4. Metabolic: functional magnetic resonance imaging

Functional magnetic resonance imaging (fMRI) measures and maps brain activity through the detection of changes associated with blood flow using an MRI scanner (Huettel, Song, & McCarthy, 2009). In this non-invasive method, test subjects lie on a bed with their head surrounded by an MRI scanner that causes the atom particles in the head to align with the magnetic field (Bercea, 2012; Zurawicki, 2010). The MRI scanner tracks blood oxygenation in the brain and exploits the magnetic properties of oxygenated and deoxygenated blood, which correlates with the underlying neuronal activity (Kwong et al., 1992; Purves et al., 2008). It also provides a three-dimensional view of the brain with coordinates that denote the areas in the brain (Bercea, 2012; Zurawicki, 2010). So, when a test subject is exposed to a marketing stimulus, certain areas in the brain will receive more oxygenated blood flow than they usually do, creating distortions in the magnetic field emitted by hydrogen protons in the water molecules in the blood of the brain area, all of which are captured in the MRI scanner (Morin, 2011; Plassmann et al., 2007). A computer screen connected to the MRI scanner allows neuroscientists to view the changes of the signals in real time by displaying colored areas overlapping the gray-scale image of the brain (Bercea, 2012; Zurawicki, 2010). More important, fMRI offers neuroscientists the benefit of high spatial resolution that is absent in most electromagnetic methods, but at the cost of low temporal resolution, whereby the higher the spatial resolution, the lower the temporal resolution (Kenning & Linzmajer, 2011; Morin, 2011). fMRI is expensive

and restrictive in its application (Ariely & Berns, 2010; Bercea, 2012; Plassmann et al., 2011). However, it is widely available (Morin, 2011). Nonetheless, the substantial advantage gained from its wide spatial resolution allows neuroscientists to investigate small and deep structures in the brain, which is especially useful for examining emotional responses (Morin, 2011; Zurawicki, 2010). Moreover, fMRI, through the hyperscanning method, allows neuroscientists to simultaneously scan the brain of two or more test subjects engaged in a social exchange, which can be useful for marketing investigations on social concepts, such as cooperation, trust, and reciprocity (Kenning, 2008; Kenning & Linzmajer, 2011; Montague et al., 2002).

3.1.5. Metabolic: positron emission tomography

Positron emission tomography (PET) is a metabolic-physiological method for measuring and recording two high-energy gamma quants emitted by the radioactive decay of a positron-emitting radionuclide that is introduced into the body through a biologically active molecule before test subjects are exposed to the marketing stimuli under study (Bailey, Townsend, Valk, & Maisey, 2005; Perrachione & Perrachione, 2008; Plassmann et al., 2007, 2011). PET is an invasive method that uses a battery of detectors that is placed on the head of the test subject to trace radiation pulse and show in fine detail the metabolism of glucose in the brain (Bercea, 2012; Zurawicki, 2010). The gamma quants detected are used to calculate the points of origin from their respective path differences, thus allowing inference of the blood flow or metabolic rate within the brain from exposure to the marketing stimuli (Kenning & Linzmajer, 2011). More important, PET offers neuroscientists the advantage of high spatial resolution, which enables the detection of changes in chemical composition or flow of fluids in smaller and deeper structures in the brain (Kenning & Plassmann, 2005; Wang & Minor, 2008), but with tradeoffs such as poorer temporal resolution, restrictive application, and higher monetary costs (Bercea, 2012; Kenning & Plassmann, 2005; Kenning, Plassmann, & Ahlert, 2007; Plassmann et al., 2011). In addition, although the rapid radioactive decay limits PET to shorter tasks, PET requires averaging over fewer trails (Plassmann et al., 2011; Zurawicki, 2010). However, as PET is an invasive method that employs radioactive agents and exposes test subjects to radiation, its application to healthy subjects and for non-clinical studies is restricted (Shamoo, 2010).

3.2. Neuroscientific methods that record neural activity outside the brain

3.2.1. Electrocardiography

Electrocardiography (ECG) measures and records the electrical activity of the heart over time using external skin electrodes (Bercea, 2012; Noble, Hills, & Rothbaum, 1990). Signals from the electrical activity are determined by action potentials generated by millions of individual cells and their sequence of activation, which can be influenced by cardiac and extracardiac factors (Noble et al., 1990). In particular, the heart rate is controlled by two antagonistic systems: the sympathetic nervous system (SNS), which reflects arousal based on the automatic responses of the body to a marketing stimulus, and the parasympathetic nervous system (PNS), which reflects attention based on the conservation of energy in the body in the form of heart rate deceleration (Lang, Bolls, Potter, & Kawahara, 1999; Potter & Bolls, 2012; Wang, Lang, & Busemeyer, 2011). Careful correlation of electrocardiographic patterns with observed anatomic, pathological, and physiological data is necessary for neuroscientists to deduce, with a high grade of accuracy, the state of the heart (Noble et al., 1990). Although the physiological responses in ECG lag behind brain activity by several seconds, it remains a valuable research tool for neuroscientists in marketing to obtain real-time information about the emotional state of the test subjects in relation to exposure to a given marketing stimulus. Moreover, ECG offers the opportunity to obtain physiological responses that are less likely to be affected by social desirability biases, and at a low cost (Plassmann et al., 2011).

3.2.2. Eye tracking

Eye tracking (ET) measures and records eye positions and movements using eye trackers (Vidal, Turner, Bulling, & Gellersen, 2012). It uses an optimal camera, which can be contact lens–based, electro-oculogram-based, or video-based, to identify the position of the cornea and pupil using infrared light that evokes corneal reflection (Venkatraman et al., 2015). ET allows neuromarketers to identify and record gaze patterns and locations from neural activities to explain human behavior in response to viewing a specific marketing stimulus, and thus answer neurological marketing-related questions and, in doing so, better understand the connection between what the test subjects see and how they react to the marketing information they process. More important, ET provides insights into temporal processes with high temporal resolution at a low cost (Plassmann et al., 2011; Venkatraman et al., 2015). It is also highly accessible and can be easily set up (Plassmann et al., 2011). Notably, ET provides realistic evidence of what people are likely to look at, which makes it a powerful method for neuromarketers to evaluate marketing effectiveness.

3.2.3. Facial electromyography

Facial electromyography (fEMG) is a non-invasive method that measures and records the physiological properties of facial muscles by detecting and amplifying tiny electrical impulses generated by muscle fibers when they encounter small surface electrodes from the EMG equipment (Dimberg, Thunberg, & Elmehed, 2000; Ohme, Matukin, & Pacula-Lesniak, 2011). This method can be used to test voluntary and involuntary facial muscle movements to understand the conscious and unconscious expressions of emotions among test subjects in marketing environments (Cacioppo, Petty, Losch, & Kim, 1986, 2000; Dimberg et al., 2000; Ohme et al., 2011). More important, fEMG offers neuromarketers the ability to detect and register changes in facial expressions, as any electrical impulse generated by facial muscle activity can be measured and recorded, at a relatively low cost (Plassmann et al., 2011). This remains true even in situations in which test subjects are instructed to inhibit their emotional facial expression and emotional stimuli are weakly evocative. However, the number of muscles the fEMG can test is limited by the number of electrodes that can be attached to the face. Moreover, although this method does not apply any invasive mechanism to the body, its application is rather obstructive to regular movement and thus can alter natural expression.

3.2.4. Skin conductance

Skin conductance (SC) is a non-invasive method that measures and records the subtle changes in SC responses when the automatic nervous system (ANS) is activated (Ohme et al., 2011). ANS is activated when the skin of test subjects momentarily becomes a better conductor of electricity, which may occur from increased activity of eccrine (sweat) glands following exposure to a physiologically arousing marketing stimulus (Ohme et al., 2011; Venkatraman et al., 2015). More important, SC can be useful to neuromarketers who want to obtain a direct measure of tonic activity. However, because of the nature of the type of physiological responses captured in SC, a short delay usually occurs. It should be noted that SC simply measures the degree of arousal; it cannot offer any conclusive evidence of the direction or valence of emotional reaction. That is, both pleasurable and unpleasurable marketing stimuli can evoke large SC responses (Hopkins & Fletcher, 1994; Ohme et al., 2011; Potter & Bolls, 2012).

3.3. Neuroscientific methods to manipulate neural activity

3.3.1. Transcranial magnetic stimulation

Transcranial magnetic stimulation (TMS) stimulates nerve cells in specified regions in the brain (and thus causal testing of brain function) by sending electromagnetic impulses through the scalp and skull and into specific brain areas using a plastic case containing an electromagnetic coil that is placed directly over a specified location of the

head (Camerer, Loewenstein, & Prelec, 2005; Kenning & Linzmajer, 2011; Sliwinska, Vitello, & Devlin, 2014). This non-invasive method modulates the activity of specified areas in the brain by temporarily disrupting functions in a brain region and thus generating a short-lived virtual lesion in that area (Pascual-Leone, 1999; Paus, 2005; Sack, 2006; Walsh & Rushworth, 1999). More important, TMS, with support measures from other neuroscientific methods, offers neuroscientists the advantage of studying causality and making causal inferences with high external validity (Kenning & Linzmajer, 2011; Sliwinska et al., 2014; Walsh & Pascual-Lone, 2003). That is, TMS disrupts brain activity and allows neuromarketers to observe its effects on behavior through other neuroscientific methods that record brain activity; brain regions that significantly affect task performance indicate that the stimulated area is necessary to perform the task (Sliwinska et al., 2014). Thus, the causal observations from using TMS add more to external validity than do correlative measures produced alone through other neuroscientific methods that do not temporarily disrupt brain activity (Kenning & Linzmajer, 2011). TMS is also portable and thus can be employed in actual marketing settings (e.g., search and purchase situations) (Bercea, 2012). However, TMS has several drawbacks, including limited spatial resolution, difficulty in making exact causal interpretations due to the interconnectedness of brain areas, and the potential of longer-than-expected side effects from the radiation (Jones, 2007; Kenning & Linzmajer, 2011).

3.3.2. Neurotransmitter

Neurotransmitters (NTs) are chemical substances that enable transmission of neurological signals from one neuron to another target neuron. They are released from vesicles in synapse and received by receptors of the target neuron. Most NTs are produced from common precursors, such as amino acids and peptides, and require minimal biosynthetic steps for conversion. While introducing pharmacological drugs as interventions into the body of participants in neuromarketing studies may raise concerns among ethics committees and review boards (e.g., administration of pharmacological antagonists, such as oxytocin), alternative ways of stimulating these substances in neural systems are available, such as overloading or depleting a specific NT (e.g., phenylalanine, serotonin, tyrosine) through dietary controls. When used together with other neuroscientific methods that record neural activity inside and outside the brain, neuromarketers will be able to test for the necessity, sufficiency, and association of neuropsychological processes and consumer behavior (e.g., trust) with marketing stimuli under study (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005; Plassmann et al., 2012).

4. What are the ethical concerns with using neuroscientific methods in marketing, and how can they be addressed?

A vital area for consideration by any neuroscientist who wants to conduct research in the area of neuromarketing is the primacy of ethical considerations in the conduct of both academic and commercial neuromarketing research. Indeed, the ethical dimension of neuromarketing is one of the largest and most sensitive challenges with respect to the application of neuroscience in marketing (Pop, Dabija, & Iorga, 2014). The subsections that follow identify and briefly discuss two major ethical concerns with using neuroscientific methods in marketing: the protection of test subjects and the scientific reliability, validity, and transparency of neuroscientific findings. The last subsection discusses solutions to these concerns by formulating policies, establishing ethics committees, and engaging in responsible learning and practice. For additional readings on the topic, see Farah (2005), Lee, Brandes, Chamberlain, and Senior (2017), Murphy et al. (2008), Plassmann et al. (2012), Poldrack (2006), and Ulman, Cakar, and Yildiz (2015).

4.1. Concerns

4.1.1. Protection of test subjects

One of the ethical concerns in neuromarketing research is the protection of test subjects. Of particular relevance are the issues of informed consent, privacy, and vulnerability. More specifically, measuring and mapping the neurological responses to marketing stimuli in the human brain may threaten the autonomy of test subjects from whom certain information is waived when obtaining consent prior to research (Murphy et al., 2008; Ulman et al., 2015). Although informed consent and privacy are among the indispensable obligations that any researcher should ensure when carrying out studies that involves human subjects, the issue of adequate protection given to test subjects in neuromarketing studies is often raised when neuroscientists do not take measures to obtain informed consent and protect their privacy (Beauchamp, 1997; Murphy et al., 2008; Ulman et al., 2015). These measures include information on the procedures of the study, the benefits and risks of participating in the study, the rights of test subjects, the types of findings that may be obtained from them, and the actions taken to ensure confidentiality and privacy (Slowther & Kleinman, 2009). The importance of such protection becomes more prominent for vulnerable groups, such as children, patients, prisoners, and people (or family members of people) with neurological disease or psychological disorders, as these groups may be highly susceptible, easily deceived, or negatively affected by the use of neuroscientific technology (Farah, 2005; Luna & Macklin, 2012). Most worrying is when such protections are absent (leading to the possibility of exploitation), especially in instances when ethics review (by an ethics committee or body) is not present (Tovino, 2005). Such instances are most prominent in neuroscientific studies carried out for (1) commercial marketing purposes by commercial brands and market research companies in countries without a national regulatory body or research ethics committee system to provide ethical research oversight (see World Health Organization, 2015) and (2) academic purposes by scholars in institutions that do not provide or provide only nominal ethics guidelines, reviews, and services, especially for non-medicine-related studies (see Committee on Publication Ethics, 2003).

4.1.2. Scientific reliability, validity, and transparency

Another ethical concern with using neuroscientific methods in marketing involves scientific reliability, validity, and transparency. Of particular relevance is the scientific competency of the marketing researcher who takes on the role of a neuroscientist and the scientific quality of the neuroscientific method used to conduct the neuromarketing research (Rees & Rose, 2004; Ulman et al., 2015). More specifically, the interpretation of neuroscientific findings requires a high level of neuroscientific knowledge to appropriately mark the boundaries of the possible outcomes and limitations of using a neuroscientific method in the pursuit of transparently producing and reporting reliable, valid, and meaningful interpretations of neuroscientific observations (Illes, 2002; Ulman et al., 2015). Inadequate competency may lead to under- or overestimating neuroscientific findings, misreporting the advances in marketing discoveries, and planning and implementing faulty marketing strategies (e.g., reverse inferencing, publication bias for positive results) (see Plassmann et al., 2012; Poldrack, 2006).

4.2. Solutions

4.2.1. Formulate policies and establish ethics committees

To mitigate concerns about the protection of human subjects involved in brain research, policies for responsibly managing neuroscientific studies can be formulated. These policies may include the provision of sufficient protection for test subjects; full disclosure of goals, risks, and benefits of the study; procedures for informed consent; and explicit protocols for dealing with main and incidental

neuroscientific findings (Illes et al., 2006; Murphy et al., 2008). Although only minimal risk is associated with most neuroscientific methods, test subjects should always be advised and reminded of their right to voluntarily participate in and withdraw at any time for any reason from the study (Murphy et al., 2008). In addition, ethics committees and bodies should be established at both the institutional and national levels to safeguard the rights of human subjects, especially vulnerable subject populations (Lo, 2007; Shamoo & Resnik, 2009; Ulman et al., 2015)—these committees should review and regulate neuromarketing practices at all levels (i.e., academia, government, and industry). More important, neuromarketing researchers should always strive to beneficently serve and satisfy the needs of their target market without intentionally causing any financial and psychosocial harms (Murphy et al., 2008; Ulman et al., 2015).

4.2.2. Engage in responsible learning and practice

To mitigate concerns with reliability, validity, and transparency of neuroscientific research, marketing researchers should enroll in accredited courses and programs on neuroscience to develop and expand their knowledge in the area before attempting to conduct a neuroscientific study. In addition, the findings from any neuroscientific study should be able to clearly demonstrate scientific reliability and validity, including acknowledgment of the boundaries and limitations of the neuroscientific methods used, before making any conclusions for marketing theory and practice. Using large-scale automated meta-analytic maps of brain activation should also be valuable for marketing researchers interested in neuromarketing research for avoiding clear errors of inference and for drawing more justified conclusions (Lee et al., 2018). Alternatively, choosing to scan brain regions that are selectively activated by the mental process of interest, specifically those that can be activated by a small number of mental processes, should address the problems of reverse inferencing, as brain regions activated by a large number of mental processes are typically considered weak neuroscientific evidence for establishing causation (Plassmann et al., 2012). Moreover, adherence to a code of responsible communication and truth-in-advertising should contribute to scientific transparency (Murphy et al., 2008), avoid the trap of deceptive marketing, and help foster positive public perceptions of neuromarketing. More important, neuromarketing methods should only be used when a clear research need can be shown (e.g., research need cannot be feasibly addressed by other methods) and the benefits of selected neuromarketing methods can be clarified to justify their use (e.g., triangulation) (Lee et al., 2018; Reimann et al., 2011).

5. What are the existing contributions of neuromarketing?

The contributions neuroscientific methods can make to understand human behavior for marketing theory and practice are noteworthy. To provide an overview of prior work in the area, this article systematically reviews (through content analysis) and draws themes (through thematic analysis) from extant literature on neuromarketing, specifically through a keyword search of "neuromarketing" in the main academic outlets for marketing science based on the latest ABS list of marketing journals. The review includes conceptual, empirical, and review articles that discuss the contributions of neuroscientific methods to marketing theory and practice; book reviews (e.g., Agarwal, 2014a, 2014b, 2015; Cramphorn, 2008; Leighton & Dalvit, 2011; O'Donohoe & Young, 2008), editorials (e.g., Camerer & Yoon, 2015; Ford, 2008; Kenning, Marci, & Calvert, 2008; Stipp, 2015; Veloutsou, Guzman, Gountas, & Moutinho, 2016), and extended abstracts (e.g., Chen, Hsu, & Nelson, 2013; Koestner, Hedgcock, Halfmann, & Denburg, 2013; Lu & Dube, 2013; Reimann, MacInnis, & Bechara, 2013) were excluded from the review. The sections that follow provide a flavor of insights in extant marketing literature in which neuroscientific methods have been argued and proven to be illuminating.

5.1. Content analysis of existing neuromarketing work in academic outlets for marketing science

This article identifies 66 academic outlets for marketing science from the Association of Business Schools (ABS) list of marketing journals. These marketing journals were classified into five categories depicting the quality of excellence in research outputs: '4*'—a world elite journal (i.e., 5 marketing journals; 7.6%), '4'—a top journal (i.e., 3 marketing journals; 4.5%), '3'—a highly regarded journal (i.e., 12 journals; 18.2%), '2'—a well-regarded journal (i.e., 21 marketing journals; 31.8%), and '1'—a recognized journal (i.e., 25 marketing journals; 37.9%). However, only 21 of the 66 (31.8%) marketing journals in this list had articles on neuromarketing from 2004 to 2017 (see Table 1).

Seventy-eight articles on neuromarketing have appeared in 21 ABS-ranked marketing journals. Most neuromarketing articles have been published in category '2' (i.e., 33 articles; 42.3%), followed by category '4*' (i.e., 17 articles; 21.8%), category '3' (i.e., 19 articles; 24.3%), category '1' (i.e., 8 articles; 10.3%), and category '4' (i.e., 1 article; 1.3%). Four special issues on neuromarketing have been published in recent years—two in 2008 and one each in 2015 and 2016. More specifically, in 2008, *International Journal of Advertising* (category '2') had a special issue on advertising and the brain (7 articles in the third issue of volume 27), co-edited by Peter Kenning, Carl Marci, and Gemma Calvert, and *Journal of Consumer Behaviour* (category '2') focused on neuromarketing in general (11 articles in the fourth to fifth issue of volume 7), co-edited by Carl Senior and Nick Lee. *Journal of Marketing Research* (category '4*') had a special issue on neuroscience and marketing in 2015 (12 articles in the fourth issue of volume 52), co-edited by Colin Camerer and Carolyn Yoon, and *Journal of Product and Brand Management* (category 1) focused on branding and neuroscience in 2016 (three articles in the second issue of volume 25), co-edited by John Gountas and Luiz Moutinho. Indeed, the large number of neuromarketing articles appearing in categories '2' and '4*' may be attributed to the call for special issues in the area.

Neuroimaging (i.e., record neural activity inside the brain) neuroscientific methods (i.e., 33 articles; 42.3%), such as fMRI (most popular brain recording method) and EEG (second most popular brain recording method), are the most popular methods for neuromarketing research, followed by a conceptual or review approach (i.e., 31 articles; 39.7%), non-neuroimaging (i.e., record neural activity outside the brain) neuroscientific methods (i.e., 16 articles; 20.5%; e.g., ECG, ET, and SC), and traditional marketing research methods (i.e., 4 articles; 5.1%; e.g., analysis of variance and multiple regression analysis) (see Table 2). Articles using these methods for marketing advancement can be divided into eight broad themes—in particular, most neuromarketing scholars used these methods to provide a general outlook on neuromarketing (i.e., 29 articles; 37.2%), followed by new insights in the area of branding (i.e., 13 articles; 16.7%), advertising (i.e., 17 articles; 21.8%), decision making (i.e., 9 articles; 11.5%), product packaging and presentation (i.e., 4 articles; 5.1%), pricing (i.e., 3 articles; 3.8%), general perception on neuromarketing (i.e., 2 articles; 2.6%), and individual differences (i.e., 1 article; 1.3%). The general thrust of each theme is presented through a thematic analysis in the following section.

5.2. Thematic analysis of neuromarketing work in academic outlets for marketing science

5.2.1. General outlook on neuromarketing

The general consensus about neuromarketing among most neuromarketing scholars is that it can be used to validate, refine, or extend existing marketing theories by providing insights into underlying mechanisms, measuring implicit processes that are typically difficult to access using other approaches (e.g., decision-making response with moral consequences that are likely to be subject to self-deception and

Table 1
Content analysis of existing neuromarketing work in academic outlets for marketing science.

No	Journal title	ABS rank	Themes	Number of articles	Source
1	Journal of Consumer Psychology	4*	Branding, decision making, packaging	4	Hedgcock et al., (2012), Plassmann et al. (2012), Reimann et al. (2010). Venkatraman et al. (2012)
2	Journal of Consumer Research	4*	Branding	1	Yoon et al. (2006).
3	Journal of Marketing Research	4*	Advertising, branding, decision making, general application, individual differences, pricing, word of mouth	12	Boksem and Smidts (2015), Cascio et al. (2015), Cerf et al. (2015), Chen et al. (2015), Karmarkar et al. (2015), Lichters et al. (2016), Plassmann and Weber (2015), Plassmann et al. (2015), Pozharliev et al. (2015), Meißner et al. (2016), Telpaz, Webb, and Levy (2015), Venkatraman et al. (2015)
4	International Journal of Research in Marketing	4	Advertising	1	Couwenberg et al. (2017)
5	Journal of Advertising	3	Advertising	1	Pozharliev et al. (2017)
6	Journal of Advertising Research	3	Advertising, general application	7	Bellman et al. (2017), Deitz et al. (2016), Kennedy and Northover (2016), Lajante et al. (2017), Marci (2006), Shen and Morris (2016), Varan et al. (2015)
7	Marketing Letters	3	Branding, decision making, general application	5	Rampl et al. (2016), Reimann et al. (2012), Shiv et al. (2005), Smidts et al. (2014), Yoon et al. (2012)
8	Psychology and Marketing	3	Branding, decision making, general application, packaging, pricing	6	Alexander et al. (2015), Ambler et al. (2004), Hubert et al. (2013), Mileti et al. (2016), Reimann et al. (2011) Somervuori and Ravaja (2013)
9	Advances in Consumer Research	2	Advertising, perception	2	Barnett and Cerf (2015), Koller (2010)
10	Consumption Markets and Culture	2	General application	2	Nemorin (2017), Schneider and Woolgar (2012)
11	International Journal of Advertising	2	Advertising, general application	9	Geske and Bellur (2008), Kenning (2008), Marci (2008), Milosavljevic and Cerf (2008), Nairn and Fine (2008), Plassmann et al. (2007), Russell et al. (2017), Siefert et al. (2008), Silberstein and Nield (2008)
12	Journal of Brand Management	2	Branding	1	Santos et al. (2012)
13	Journal of Consumer Affairs	2	General application	1	Wilson et al. (2008)
14	Journal of Consumer Behaviour	2	Advertising, branding, general application, packaging	11	Butler (2008), Foxall (2008), Gakhal and Senior (2008), Garcia and Saad (2008), Hubert and Kenning (2008), Jai et al. (2014), Mesly (2017), Murphy et al. (2008), Perrachione and Perrachione (2008), Stoll et al. (2008), Vance and Virtue (2011)
15	Journal of Marketing Management	2	Branding, perception	4	Baron et al. (2017), Eser et al. (2011), Lee et al. (2017), Ratnayake et al. (2010)
16	Journal of Services Marketing	2	General application	1	Fugate (2008)
17	Qualitative Market Research: An International Journal	2	General application	2	Kenning et al. (2007), Mostafa (2014)
18	Journal of Consumer Marketing	1	Advertising, decision making, general application	3	Booth and Freeman (2014), Fugate (2007), Pileliené and Grigaliūnaitė (2017)
19	Journal of Marketing Communications	1	Advertising	1	Mostafa (2013)
20	Journal of Product and Brand Management	1	Branding, pricing	3	Al-Kwifi (2016), Boshoff and Boshoff (2016), dos Santos et al. (2016)
21	Marketing Intelligence and Planning	1	Decision making	1	Chowdhury and Samuel (2014)

Notes: In total, 21 of 66 marketing journals ranked by the ABS have articles on neuromarketing. No articles on neuromarketing are available in the following journals: 4*—Journal of Marketing and Marketing Science (2 journals); 4—Journal of Retailing and Journal of the Academy of Marketing Science (2 journals); 3—European Journal of Marketing, Industrial Marketing Management, International Marketing Review, Journal of Interactive Marketing, Journal of International Marketing, Journal of Public Policy and Marketing, Marketing Theory, and Quantitative Marketing and Economics (8 journals); 2—Academy of Marketing Science Review, Electronic Markets, International Journal of Consumer Studies, International Journal of Market Research, International Journal of Retail and Distribution Management, Journal of Business and Industrial Marketing, Journal of Business-to-Business Marketing, Journal of Macromarketing, Journal of Marketing Theory and Practice, Journal of Personal Selling and Sales Management, Journal of Retailing and Consumer Services, and Journal of Strategic Marketing (12 journals); 1—Advances in International Marketing, Australasian Marketing Journal, Corporate Communications: An International Journal, Corporate Reputation Review, Health Marketing Quarterly, International Journal of Bank Marketing, International Journal of Internet Marketing and Advertising, International Journal of Nonprofit and Voluntary Sector Marketing, International Review of Public and Non-profit Marketing, International Review of Retail, Distribution and Consumer Research, Journal of Customer Behavior, Journal of Fashion Marketing and Management, Journal of Financial Services Marketing, Journal of Global Marketing, Journal of Marketing Channels, Journal of Marketing for Higher Education, Journal of Non-profit and Public Sector Marketing, Journal of Relationship Marketing, Review of Marketing Science, Science Marketing Quarterly, and Social Marketing Quarterly (21 journals).

Table 2
Content analysis of neuromarketing themes in academic outlets for marketing science.

No	Theme	Number of articles	Source	Method
1	General outlook on neuromarketing	29	Baron et al. (2017)	General review
			Booth and Freeman (2014)	Panel mapping
			Butler (2008)	General review
			Foxall (2008)	General review
			Fugate (2007)	General review
			Fugate (2008)	General review
			Garcia and Saad (2008)	Conceptual
			Hubert and Kenning (2008)	General review
			Kennedy and Northover (2016)	General review
			Kenning (2008)	General review
			Kenning et al. (2007)	General review
			Marci (2008)	General review
			Lajante et al. (2017)	Conceptual
			Lee et al. (2017)	General review
			Milosavljevic and Cerf (2008)	Conceptual
			Mileti et al. (2016)	Conceptual
			Mostafa (2014)	General review
			Murphy et al. (2008)	General review
			Nairn and Fine (2008)	General review
			Nemorin (2017)	Conceptual
			Perrachione and Perrachione (2008)	General review
			Plassmann et al. (2007)	General review
			Plassmann et al. (2015)	Conceptual
			Reimann et al. (2011)	General review
			Schneider and Woolgar (2012)	General review
			Smidts et al. (2014)	General review
			Varan et al. (2015)	General review
			Wilson et al. (2008)	General review
			Yoon et al. (2012)	General review
2	General perception on neuromarketing	2	Eser et al. (2011)	Analysis of variance
			Koller (2010)	Multiple regression analysis
3	Advertising—e.g. attention, affect, memory, desirability, preferences, and sales.	17	Barnett and Cerf (2015)	EEG
			Bellman et al. (2017)	SC
			Boksem and Smidts (2015)	EEG
			Cerf et al. (2015)	Single neuron recording
			Couwenberg et al. (2017)	fMRI
			Deitz et al. (2016)	EEG
			Geske and Bellur (2008)	EEG
			Marci (2006)	ECG, SC
			Mostafa (2013)	fMRI
			Pilelienė and Grigaliūnaitė (2017)	EEG, ET, *Z*-test
			Pozharliev et al. (2017)	General review
			Russell et al. (2017)	ET
			Shen and Morris (2016)	fMRI
			Siefert et al. (2008)	ECG, ET, SC
			Silberstein and Nield (2008)	SST
			Vance and Virtue (2011)	Divided visual field paradigm
			Venkatraman et al. (2015)	EEG, fMRI
4	Branding—e.g. brand attention, experience, liking, recall, and traits (or personality)	13	Al-Kwifi (2016)	fMRI
			Ambler et al. (2004)	MEG
			Boshoff and Boshoff (2016)	EEG
			Chen et al. (2015)	fMRI
			Gakhal and Senior (2008)	SC
			Plassmann et al. (2012)	Conceptual
			Pozharliev et al. (2015)	EEG
			Rampl et al. (2016)	fMRI
			Reimann et al. (2012)	fMRI
			Ratnayake et al. (2010)	fMRI
			Santos et al. (2012)	fMRI
			Venkatraman et al. (2012)	Conceptual
			Yoon et al. (2006)	fMRI
5	Product packaging and presentation—e.g. design.	4	Hubert et al. (2013)	fMRI
			Jai et al. (2014)	fMRI
			Reimann et al. (2010)	fMRI
			Stoll et al. (2008)	fMRI
6	Pricing—e.g. cost consciousness, price primacy	3	dos Santos et al. (2016)	fMRI
			Karmarkar et al. (2015)	fMRI
			Somervuori and Ravaja (2013)	fEMG
7	Individual differences	1	Plassmann and Weber (2015)	Automated structural MRI

(*continued on next page*)

Table 2 (*continued*)

No	Theme	Number of articles	Source	Method
8	Decision making—e.g. purchase decision, word-of-mouth recommendation	9	Alexander et al. (2015)	Blood testing, ECG
			Cascio et al. (2015)	fMRI
			Chowdhury and Samuel (2014)	Artificial neural networks
			Hedgcock et al. (2012)	fMRI
			Lichters et al. (2016)	Serotonin insertion
			Meißner et al. (2016)	ET
			Mesly (2017)	fMRI
			Shiv et al. (2005)	General review
			Telpaz et al. (2015)	EEG

Notes: In total, 8 broad themes encapsulate 78 articles on neuromarketing in academic outlets for marketing science. The collection of articles consists of 23 general review articles, 8 conceptual articles, 33 studies using neuroimaging neuroscientific methods (i.e. 20 studies using fMRI, 9 studies using EEG, 1 study using automated structural MRI, 1 study using MEG, 1 study using SST, and 1 study using single neuron recording), 16 studies using a combination of non-neuroimaging neuroscientific methods (e.g. 3 studies using ECG, 4 studies using SC, 4 studies using ET, 1 study using artificial neural networks, 1 study using blood testing, 1 study using divided visual field paradigm, 1 study using fEMG, and 1 study using serotonin insertion), and 4 studies using traditional methods to study neuromarketing (e.g. 1 study each using analysis of variance, multiple regression analysis, panel mapping, and *Z*-test).

social desirability biases), distinguishing between psychological processes (e.g., quick, intuitive, and suboptimal choices vs. deliberative and compensatory decisions), delineating individual differences (e.g., responsiveness to reward or pleasure vs. punishment or pain), and improving predictions of behavior (e.g., pre-decisional activation in relevant brain regions can predict subsequent choice) (Baron, Zaltman, & Olson, 2017; Butler, 2008; Foxall, 2008; Fugate, 2007, 2008; Garcia & Saad, 2008; Hubert & Kenning, 2008; Kennedy & Northover, 2016; Kenning, 2008; Kenning et al., 2007; Lee et al., 2017; Marci, 2008; Milosavljevic & Cerf, 2008; Mostafa, 2014; Nemorin, 2017; Perrachione & Perrachione, 2008; Plassmann et al., 2007, 2015; Reimann et al., 2011; Schneider & Woolgar, 2012; Smidts et al., 2014; Varan, Lang, Barwise, Weber, & Bellman, 2015; Yoon et al., 2012).

Nonetheless, neuromarketing has several limitations that can impede the extension and validation of its application, such as high-priced and time-restricted neuroimaging experiments, large and immovable devices confined to artificial laboratory environments, use of a single neuroimaging device and technology at a time, and potentially unethical manipulation of research subjects (Mileti, Guido, & Prete, 2016; Murphy et al., 2008; Nairn & Fine, 2008; Wilson, Gaines, & Hill, 2008). Nanotechnologies is a potential solution to complement neuroscientific methods to make possible the acts of carrying out non-invasive and non-intrusive experiments in shopping places, monitor consumers' mental processes in real time, combine different technologies to corroborate results obtained by different neuroscientific tools, integrate neurophysiological field indicators with laboratory neuroimaging results, and highlight ethical issues raised from the use of these novel, portable, and easy-to-use nanodevices (Mileti et al., 2016). Similarly, panel mapping of each consumer's mental processes in a market-relevant context is a potential solution that can be supplemented with neuromarketing methods to help overcome the shortcomings in neuromarketing of being unable to distinguish qualitative differences (Booth & Freeman, 2014). Recently, new templates to improve the reliability of neuromarketing processing methods have emerged (e.g., fEMG) (Lajante, Droulers, & Amarantini, 2017), but further work in the area remains necessary.

More important, existing literature on neuromarketing has offered limited guidance on how to conduct strong neuromarketing research, with most conceptual and review articles discussing only the basic features of different neuroscientific methods. Greater user-oriented methodological primers, such as those that offer guidance on neuroscientific data collection, analysis, interpretation, and reporting for neuromarketing, are highly encouraged. Furthermore, given the concentrated focus of existing neuromarketing research on neural systems as a reactive modular system, future neuromarketing research is encouraged to go beyond this focus and move to a more dynamic network view of neural systems (e.g., spontaneous neural activity) (Lee et al., 2018).

5.2.2. General perception on neuromarketing

In contrast with other themes that examine the use of neuroscientific methods to understand human responses to marketing stimuli, studies under this theme explore the perceptions of the average person on the use of neuroscientific methods for marketing. The work of Koller (2010) offers insights into the area from the consumer perspective, in terms of addressing issues such as willingness of the target market to participate in, ethical and health reservations about, risks of, and intrinsic and extrinsic motivation for participating in neuromarketing studies. The work of Eser, Isin, and Tolon (2011) extended the work of Koller (2010) by including perspectives from marketing academics, neurologists, and marketing professionals. Their study reveals three factors perceived as the most important aspects of neuromarketing to the three groups of people: interest and participation, knowledge and awareness, and ethics. Neurologists and marketing professionals perceive neuromarketing more favorably than marketing academics, as neurologists are familiar with the application of neuroimaging techniques and marketing professionals have a tendency to seek competitive advantages and adapt to changing conditions in their businesses.

Nonetheless, insights under this theme are relatively less rich than those of other themes. Furthermore, the importance of shaping a positive perception and outlook of neuromarketing is paramount for neuromarketing to gain acceptance and practice among marketing academics and practitioners, as well as the general public. If not, the intention–behavior gap that impedes many other types of consumer and organizational behaviors may arise in neuromarketing. For example, academics and marketers who are interested in using neuroscience for marketing endeavors may end up abandoning their pursuit of neuromarketing research when they are not able to locate good practical guides (or methodological primers) or subject-matter experts who are willing to collaborate with them. Thus, future research that extends current understanding of neuromarketing, such as studies that explore ways to enhance desirable perceptions and mitigate undesirable perceptions of neuromarketing among academics, practitioners, and the public, is strongly encouraged.

5.2.3. Advertising

Most often, neuroscientific methods explain the most variance in consumer emotions (e.g., upregulation of emotions in response to emotional appeals, such as fear appeals) and in advertising elasticities or success (e.g., attention, affect, memory, desirability) beyond baseline traditional measures (e.g., traditional self-reports) (Barnett & Cerf, 2015; Bellman et al., 2017; Cerf, Greenleaf, Meyvis, & Morwitz, 2015; Deitz, Royne, Peasley, & Coleman, 2016; Geske & Bellur, 2008; Marci, 2006; Pilelienė & Grigaliūnaitė, 2017; Pozharliev, Verbeke, & Bagozzi, 2017; Russell, Swasy, Russell, & Engel, 2017; Shen & Morris, 2016;

Siefert et al., 2008; Silberstein & Nield, 2008; Venkatraman et al., 2015). For example, the work of Couwenberg et al. (2017) explains how the functional and experiential executional elements of advertisements activate different brain regions associated with lower- and higher-level cognitive processes to influence advertising effectiveness. The work of Vance and Virtue (2011) using a divided visual field paradigm shows that metaphor, literal, or neutral slogans can reflect target words presented to either the left visual field–right hemisphere or the right visual field–left hemisphere of the brain, whereby a right hemisphere advantage was present for metaphoric and literal slogans, though metaphoric slogans were remembered better than literal ones. Mostafa (2013) observes a similar intensity of neural activity in the context of surrealistic imagery in advertising. Such understanding, when translated into a macro-marketing context, can help predict individual and population-wide preferences for advertised offerings and thus, in principle, can be used as a neural marker for commercial sales and success (e.g., movies) (Boksem & Smidts, 2015).

Taken together, these findings suggest that advertising is amenable to neuroscientific investigation. To move forward, future neuromarketing research should consider scrutinizing in greater depth the distinct neuronal pathways underlying ad recognition and recall as well as post-advertisement decision making. In doing so, research should be able to shed greater light on highly promising areas in advertising, such as the contribution of different components and duration of advertising to the magnitude and valence of brand memories under the persuasive hierarchy (i.e., advertisements that provide information and reasons to buy under the assumption of sequential mental processing) and reinforcement (i.e., continuing process of shaping, altering, and reinforcing preferences) models of advertising (Plassmann et al., 2007).

5.2.4. Branding

Brand associations (e.g., brand personality traits) can exist a priori in the minds of consumers, which suggests that the types and properties of brands that consumers are thinking about can be reliably predicted from patterns of neural activations in the brain (Ambler, Braeutigam, Stins, Rose, & Swithenby, 2004; Chen, Nelson, & Hsu, 2015; Santos, Seixas, Brandao, & Moutinho, 2012). This notion is supported by several neuromarketing scholars in the area, whose studies offer evidence that neuroscience (or neural) data can be used to specify brand traits (or personality) that correspond to preference (Chen et al., 2015; Venkatraman, Clithero, Fitzsimons, & Huettel, 2012; Yoon, Gutchess, Feinberg, & Polk, 2006) and to determine representation and attention (e.g., identification of choice set and saliency of options of brands, Gakhal & Senior, 2008; Plassmann et al., 2012), learning (e.g., updating of brand associations, Plassmann et al., 2012), predicted and experienced value (e.g., how much consumers will enjoy a brand, Plassmann et al., 2012), remembered brand value (e.g., memory of brand linking, how linking of a brand is encoded, consolidated, and retrieved, Plassmann et al., 2012; Ratnayake, Broderick, & Mitchell, 2010), brand choice (e.g., choice of novel brands over familiar brands, Reimann, Castano, Zaichkowsky, & Bechara, 2012), brand tarnishment (e.g., brand names that have been diluted, blurred, or tarnished by competitors, Boshoff & Boshoff, 2016), and brand switching behavior (Al-Kwifi, 2016). These methods can also be used to assess human responses to brands under different marketing conditions. For example, Pozharliev, Verbeke, Van Strien, and Bagozzi (2015) found that higher attention allocation, emotional value, and motivational significance were present during passive viewing of luxury-branded but not basic-branded product and that the presence of another person magnified the emotional effect of brand type, particularly for luxury-branded products. The context of application can also be extended to human behavior toward employer brands. For example, Rampl, Opitz, Welpe, and Kenning (2016) note that decision making for employer first-choice brands (as compared with less attractive employer brands) is associated with increased activation in brain areas linked to emotions and with decreased activation in neural areas linked to working memory and reasoning, which indicates that neural processing of employer brands differs from that of consumer brands.

Indeed, these studies, through neuroscientific methods, demonstrate how known biological factors may influence brand preference and choice. Given the breadth of neuromarketing research on branding, future research that improves its depth is highly encouraged. More specifically, future research on predicted values of brands (i.e., the belief about the experienced value of brands at some point in the future) could assess the associations of predicted value signals in stratum with favorableness of brand associations. Research could also take a step forward by measuring the intensity and valence of experienced brand value from a neurological perspective or scrutinizing the dynamic nature of implicit and explicit brand memories. These directions should provide a useful starting point to build on extant work on branding through neuromarketing investigations.

5.2.5. Product packaging and presentation

Neuroimaging studies on product packaging and presentation reveal several notable insights. Reimann, Zaichkowsky, Neuhaus, Bender, and Weber (2010) found that products with aesthetic packages significantly increase the reaction time of consumers' choice responses and encourage consumers to choose such products over well-known brands in standardized packages, even when they are higher priced. Other studies, such as those by Hubert, Hubert, Florack, Linzmajer, and Kenning (2013) and Stoll et al. (2008), add that attractive packaging evokes more intensive activity changes in brain areas associated with positive emotions, reward, and impulsive and reflective systems; unattractive packages are associated with less intensive activities in these brain regions while activating brain areas associated with negative emotions. These findings suggest that strong impulsive buying tendencies can be predicted by stimulating neural activity in brain regions associated with positive emotions and with impulsive and reflective processes. In another study, Jai et al. (2014) showed that sensory-enabling presentations in the form of image zooming and rotation videos evoke different cognitive and affective brain functions during product evaluation and purchase decision processes, such that image zooming evokes more visual perceptions while the rotation view evokes more mental imagery, pleasure, and reward anticipation.

While product packaging and presentation is one of the closest brand touch points to consumers, especially for goods located at the point of sale (e.g., fast-moving consumer goods) (Silayoi & Speece, 2004), the relationship between visual processing and product packaging and presentation still suffers from lack of theory (Stoll et al., 2008). Further investigation in this area is necessary for three main reasons. First, two-thirds of consumer purchase decisions are made in-store, which explains why many brands tend to allocate larger budgets to product packaging and presentation rather than advertising (Schoormans & Robben, 1997). Second, the interactions between consumers' sensory nervous system is at the forefront of consumer decision making, which coincides with the purpose for using neuroscientific methods to advance marketing theory and practice (Stoll et al., 2008). Third, the concept of product is not limited to goods, but also includes services, people, and ideas (Kotler & Armstrong, 2005). Thus, marketing research that uses neuroscience theories and methods to optimize the design of product packaging and presentation (e.g., location of information) should provide rich insights into the differences in neural activation among attractive, unattractive, and neutral designs for a range of products and product categories (e.g., convenience, shopping, specialty, unsought).

5.2.6. Pricing

While neuroscientific methods show that consumers who view products before their price produce evaluations strongly related to product attractiveness or desirability, the same methods also demonstrate alterations in the cognitive process of valuation. For example, Karmarkar, Shiv, and Knutson (2015) found that the overall evaluations

of a product's monetary worth (as observed in altered patterns of activity in the medial prefrontal cortex immediately before making a purchase decision) were higher when consumers received early exposure to price (or price primacy) and thus may be useful to encourage purchases of bargain-priced products when their worth is easily recognized. Similarly, dos Santos, Martins, Ferreira, Ramalho, and Seixas (2016) demonstrate that the pricing of different types of products may influence consumers' buying decisions; in their study, which identified the price influence of national versus own-label brands by switching high and low prices for both brands, they found that higher-priced national brands and lower-priced own-label brands led to more buying decisions. Somervuori and Ravaja (2013) produce similar results and highlight the importance of emotional factors in pricing; their study shows that low prices and national brand products induce higher positive emotions than high prices and private-label products and also that positive emotions lead to greater purchase intentions.

Taken together, the findings from these neuromarketing investigations lend support to extant literature that shows that price evokes general considerations of worth regardless of whether products are known or unknown before consumption. To build on these findings, future neuromarketing research should consider extending the use of neuroscientific theories and methods to examine the effects of price primacy in relation to other elements of the marketing mix in post-consumption scenarios, such as those that evoke cognitive dissonance (Davvetas & Diamantopoulos, 2017). Furthermore, from a neurological standpoint, the activation of the nervous system in anticipation of cognition (e.g., benefit, cost, risk) and a certain emotion (e.g., happiness, pleasure, pain, regret) as a result of pricing (e.g., cost-, product-, competition-, relationship-, and value-based pricing) and price adjustment (e.g., allowances, discounts, and segmented-based, psychological-based, and promotional-based pricing) strategies and how such anticipation might influence consumers' pre- and post-consumption behaviors (e.g., purchase, patronage, loyalty) would be worthy of further investigation.

5.2.7. Individual differences

Neuroscientific methods offer new ways to measure heterogeneity in consumer behavior. In particular, this is done by measuring the differences in individual sensitivity across regions or structural differences in the brain. Such an understanding at the neural level of brain activity can contribute new ways for segmentation and target marketing for marketers (Camerer & Yoon, 2015). For example, Plassmann and Weber (2015) demonstrated how individual differences in gray matter volume in brain areas associated with personality traits moderate the extent to which consumers respond to marketing-based expectancy efforts (e.g., price). More specifically, their study shows that consumers high in reward seeking, low in somatosensory awareness, and high in need for cognition tend to be more responsive to marketing placebo effects.

More important, although neuroscience offers strong evidence that the variation in consumer behavior resides on the cellular basis of the brain and that individual personalities can be influenced by genetics (Hariri & Holmes, 2006; Montazeribarforoushi, Keshavarzsaleh, & Ramsøy, 2017; Ramsøy & Skov, 2010), connecting consumer behavior with personality traits and individual differences remains a challenging task. Indeed, neuromarketers who adopt a sole focus on end results (e.g., consumption and purchase decision) may end up reporting misleading results, thus causing them to fall into the gray areas of ethical concerns of neuromarketing discussed herein. This is because consumers who go through the decision-making process may end up purchasing and consuming the same brand or product, but the underlying cognitions and emotions stimulated from the reactive processes in neural systems along this decision-making process may be relatively different. Neuroscience offers pathways to obtain insights into these processes, which may be useful to marketers to better engage in market segmentation, targeting, and positioning activities. Thus, neuromarketing investigations that perform detailed trait analyses by scrutinizing both individual differences and similarities when examining relationships between marketing stimuli and behavioral responses of target segments should benefit from finer-grained discoveries of causal marketing insights.

5.2.8. Decision making

Through neuroscientific methods, marketing scholars can observe the variability in choice behavior and decision making as a result of a biological mechanism. Such observations may include context-sensitive variation in the levels of NTs (or neuromodulators) in the brain as well as attention, heart, and respiratory rates in the neural system, which can produce important implications for understanding human behavior and for marketing theory and practice (Alexander, Tripp, & Zak, 2015; Hedgcock, Vohs, & Rao, 2012; Meißner, Musalem, & Huber, 2016; Mesly, 2017; Shiv et al., 2005). For example, Lichters, Brunnlieb, Nave, Sarstedt, and Vogt (2016) reduced the levels of the NT serotonin in the brain to diminish the availability of cognitive resources in test subjects (so as to replicate psychological and physiological states of mood, hunger, stress, and sleep deprivation). Their results indicated strong consumer preferences for product options positioned as a compromise in a given choice set, rather than for more extreme alternatives (i.e., the compromise effect), and a higher tendency to avoid purchasing. Telpaz et al. (2015) measured neural activity associated with product viewing (without making any actual product choice at the viewing stage) with an EEG and compared the results with the choices made between pairs of the same product after the measurement was taken. Findings from the comparison suggest that consumers' future choices of products can be predicted using this widely available neuroscientific method. The accuracy of prediction, however, is dependent on the ordinal and cardinal distance of EEG data, whereby the larger the difference in EEG activity between two products, the better the predictive accuracy of the neuroscientific findings. In contrast, Chowdhury and Samuel (2014) offer unique insight into the neural activity through artificial neural networks with regard to the behavioral pattern of customers while purchasing energy-efficient products; their study finds that environmental consciousness does not drive green consumerism, and thus offers new evidence from neuromarketing to the intention–behavior gap in extant marketing literature. The work of Cascio, O'Donnell, Bayer, Tinney, and Falk (2015) shows that neuroscience can also be used to understand recommendation activities among consumers, such as by measuring and evaluating the neural processes associated with making recommendations to others, with and without information about peer recommendations of the type commonly available online. Their study found that the neural mechanism implicated in the susceptibility to social influence and the greater consideration of the mental states of others contribute to explaining other-directed recommendations (i.e., the act of changing recommendations to others in a way that is consistent with the feedback from peer recommendations).

Indeed, target segments may make a similar decision, but the way they arrive at that decision may differ. Neuroscience empowers marketers to understand this difference from a neurological standpoint (i.e., neural circuity). The findings discussed herein indicate that neuroscience adds value to marketing research because it enhances the ability of researchers to make inferences beyond the usual variables and paradigms, specifically by making empirically testable claims about both decision processes and their output. More important, with the application of neuroscience, neuromarketers will be in a better position to generalize causal insights into consumer decisions because they will be able to explain contextual influences, especially those of the marketing mix, that may interact with the different neural circuitry and, thus, to develop and implement marketing interventions that can influence those decisions more effectively (Yoon et al., 2012). As a whole, the findings from this theme, as well as those from other themes, contribute to an understanding of the rationales behind the different types of human behaviors and marketing outcomes as a result of

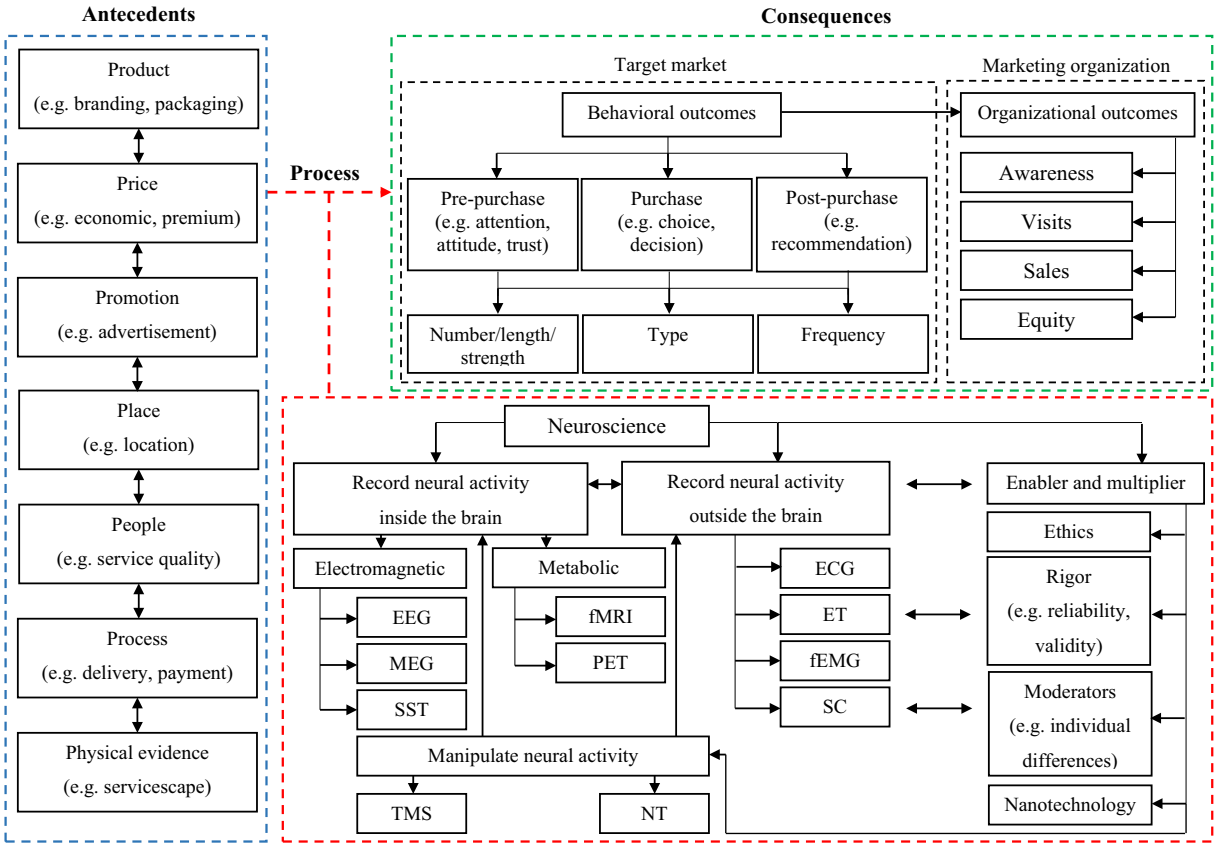

Fig. 2. A road map for neuromarketing research.

exposure to various marketing stimuli from the neuroscience perspective.

6. What can future research contribute to neuromarketing?

The systematic overview of existing neuromarketing research, specifically in the academic outlets for marketing science (as defined and ranked by ABS), shows that the potential of using neuroscientific methods for gaining insights into a wide spectrum of human behavior and marketing outcomes has met with increasing recognition from academics and practitioners in the area. Notwithstanding the extant discussion in this article on the concept of, methods for, ethical issues related to, and contributions from neuromarketing, the need for greater actionable research within this complex field remains (Daugherty et al., 2016; Daugherty & Thomas, 2016). To this end, this article presents a new roadmap for neuromarketing research to fully unlock the potential of neuromarketing to meaningfully contribute to a greater understanding and application of the brain and neural activity for the advancement of marketing science (see Fig. 2). Note that the provided roadmap is not an exhaustive list of pathways for neuromarketing research; rather, it is intended to be a source that spurs new impetuses for advancing marketing science by delineating the main roots from which new branches of neuromarketing research can emerge. Specifically, the roadmap for neuromarketing research has three main parts: antecedents, process, and consequences.

6.1. Antecedents

The antecedents to neuromarketing research encapsulate the marketing stimuli that neuromarketing researchers want to study. In particular, the marketing stimuli can take the form of the seven elements in the extended marketing mix: product (e.g., aspects and design of branding and packaging), price (e.g., economic vs. premium pricing strategies), promotion (e.g., digital and physical advertisement design), place (e.g., location of the product on shelf and the store), people (e.g., service quality), process (e.g., delivery and payment processes), and physical evidence (e.g., servicescape in the marketing environment). These elements can be investigated in various ways, such as by using a single part (e.g., brand recall) or multiple parts (e.g., brand awareness, association, and recall) of a single marketing-mix element (e.g., product) or a single part (e.g., brand image and store location) or multiple parts (e.g., brand image and aesthetic packaging of a product with economic and premium pricing strategies) of multiple marketing-mix elements (e.g., single aspect of product and single aspect of place, multiple aspect of product and multiple aspect of price).

6.2. Process

Next, the process to neuromarketing research facilitates the linkages between its antecedents and consequences—it explains how marketing outcomes can be predicted using specific types and combinations of marketing stimuli in response to human behavior based on the insights and rationales derived from using neuroscientific methods. As previously discussed, neuroscientific methods can be classified as tools and techniques that record neural activity either inside (i.e., EEG, MEG, SST, fMRI, and PET) or outside (i.e., ECG, ET, fEMG, and SC) the brain; those that record brain activity can be further classified as electromagnetic (i.e., EEG, MEG, and SST) and metabolic (i.e., fMRI and PET). Furthermore, TMS and NTs allow neuromarketers to control and manipulate neural activity to better infer causal findings from neuromarketing investigations. Most often, a single neuroscientific method is used, but taking a mixed methods approach by using a combination of neuroscientific methods is possible and is highly encouraged as it enables the triangulation of neuromarketing findings. For example, using

EEG or fMRI with ET can help neuromarketers correlate the activation in brain areas to gaze patterns produced by test subjects from exposure to particular marketing stimuli, thereby allowing neuromarketers to make more accurate predictions of marketing outcomes based on the observed relationships between the biological mechanism and the marketing stimuli under study. These methods can also be used to investigate a wide variety of moderators to the antecedents and consequences under study, such as the influence of individual differences; with the advancement of technology, it is possible that many of these methods will be synced with nanotechnologies to enable such investigations to occur in the actual marketplace. More important, usage of neuroscientific methods require good ethical conduct in the planning and implementation of neuromarketing experiments, such as the provision of sufficient protection for test subjects; full disclosure of goals, risks, and benefits of the study; procedures for informed consent; explicit protocols for dealing with main and incidental neuroscientific findings; and ethical review before study (Murphy et al., 2008). Moreover, the scientific rigor of neuromarketing studies need to be established and demonstrated (e.g., reliability and validity of findings) transparently (e.g., detailing the experimental procedure and disclosing that procedure to the public). As most neuromarketing studies have assumed either a conceptual or an applied route to investigation, the methodological route to investigation is a promising area that can be further developed to identify potential methodological issues in neuroscientific experiments, especially those related to the reliability and validity of scientific rigor in neuromarketing findings.

6.3. Consequences

Finally, the consequences of neuromarketing research encapsulate the marketing outcomes that neuromarketing researchers wish to predict. In particular, marketing outcomes can take the form of behavioral outcomes produced by the target market and the organizational outcomes produced by the marketing organization, the latter of which is influenced and predicted by the former. In terms of behavioral outcomes, neuromarketing researchers can choose to investigate pre-purchase (e.g., attention, attitude, trust), purchase (e.g., choice, decision), or post-purchase (e.g., recommendation) behavior or investigate a combination of these types of behavior over time; the nature of these behavior may be implicit, such as those that are cognitive (e.g., assessing benefits/costs) or emotional (e.g., likability, impulsiveness), or explicit (e.g., making an actual product selection or purchase decision). The intensity of these behavioral outcomes can be tested in several ways, such as by number (or length or strength; e.g., number of brand recalls, length of attention span, strength of positive or negative attitude), type (e.g., emotions toward the types of people recommended, such as close or distant family/friends), and frequency (e.g., reactions to promotions done daily, weekly, monthly, seasonally, yearly). In turn, these behavioral outcomes, as a neural marker, should help neuromarketers better predict organizational outcomes in marketing, such as customer awareness, visits, sales, and brand equity.

7. Conclusion

Until recently, marketing academics and practitioners have had to rely on what they were told or observed (e.g., self-reports, behavioral measures), not what was, to quote the old saw, going on inside someone's head (i.e., brain and neural activity). The advent of neuroscientific methods holds the promise of helping the marketing community transcend this final barrier by distinguishing the processes that may appear identical, or broadly similar, using insights to the brain and neural activity to predict people's unobservable and observable actions, such as what they think, feel, say, and do. As such, neuroscience offers marketing academics and practitioners an exciting new window into the underlying mental processes and activities experienced by their target markets when exposed to specific types of marketing stimuli, and thus it holds great potential for advancing marketing theory and practice.

Despite the limitations of a general review (e.g., absence of empirical data and analysis), best efforts have been taken to produce an objective overview of the boundaries and frontiers of neuromarketing, through the use of an integrated knowledge inquiry approach, and a systematic review, through content and thematic analyses. Thus, it is hoped that the articulations in this article on the concept of, methods for, ethical issues related to, and contributions from neuromarketing, as well as the roadmap for neuromarketing research, will help clarify and propel greater interest and actionable research in neuromarketing, specifically in terms of moving from work focused on cataloging brain regions associated with marketing stimuli to testing and refining constructs, procedures, and strategies central to advancing marketing theory and practice.

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