

Glenn Leshner, Russell B. Clayton, Glenna Read, Kevin Wise

11 A Neuroscience Perspective on Consumer Responses to Marketing Communication

Abstract: Neuromarketing is the application of biometric tools not only to measure message effects but also to provide insights into psychological processes and states. In this chapter, we discuss neuromarketing—its meaning, theoretical basis, benefits, drawbacks, ethical considerations—and summarize the tools and methods most often used by consumer neuroscience researchers. We describe measures of both the central and peripheral nervous systems and explain how they can inform cognitive and emotional processing of media. A key feature of this approach is not only the tools neuromarketing researchers may employ, but also what those measures may mean in terms of consumer cognition, emotion, and behaviors.

Keywords: Neuromarketing Measures, Embodied Mind, Cognitive and Emotional Processing of Media

Neuromarketing is the application of biometric tools not only to measure message effects but also to provide insights into psychological processes and states. In this chapter, we discuss neuromarketing—its meaning, theoretical basis, benefits, drawbacks, ethical considerations—and summarize the tools and methods most often used by consumer neuroscience researchers. We describe measures of both the central and peripheral nervous systems and explain how they can inform cognitive and emotional processing of media. A key feature of this approach is not only the “tools” neuromarketing researchers may employ, but also what those measures may mean in terms of consumer cognition, emotion, and behaviors. Although data from the measures we discuss here may be interesting and practical themselves, these measures are most useful when they indicate psychological and emotional states during message exposure that inform how individuals cognitively and emotionally process marketing communication touchpoints.

Several definitions of neuromarketing appear in the literature. For example, the Neuromarketing Science and Business Association (NMSBA) states, “Neuromarketing uses neuroscience to reveal subconscious consumer decision-making processes. Neuromarketers study brain and biometric responses, as well as behavior, to understand and shape how consumers feel, think, and act.” Similarly, Harrell (2019) said, “Neuromarketing’ loosely refers to the measurement of physiological and neural signals to

Glenn Leshner, Gaylord College of Journalism and Mass Communication, University of Oklahoma

Russell B. Clayton, School of Communication, Florida State University

Glenna Read, Grady College of Journalism and Mass Communication, University of Georgia

Kevin Wise, College of Media, University of Illinois Urbana-Champaign

gain insight into customers’ motivations, preferences, and decisions, which can help inform creative advertising, product development, pricing, and other marketing areas.” Nearly all other definitions tend to focus on the application of biometrics measures to test marketing research questions. It is clear from these definitions that consumer neuroscience tools and approaches are employed to provide richer and deeper insights into consumer knowledge, attitudes, and behaviors than can be observed through traditional measurement means, such as self-reports in surveys, questionnaires, focus groups, and so on.

Globally, advertising and marketing spending in 2024 topped US\$1.77 trillion (PQ Media, 2025). Given the importance to advertisers, marketers, and governments of measuring and evaluating consumers’ behaviors, it is not surprising that marketers have turned to cognitive neuroscience (neuromarketing) to better understand the impacts of their messages. One important characteristic and advantage of employing biometrics in neuromarketing research is the measure of second-by-second physiological response over time during message exposure, which provides substantial insight into consumer responses beyond traditional self-report data. Although potentially informative, self-reported data suffer from a number of drawbacks, enumerated in Table 11.1.

Table 11.1: Potential Drawback of Self-Report Data.

1)	Self-reports rely on subjective memory (bias)
2)	Self-reports may provide roughly “averaged” retroactive responses
3)	Self-reports provide no data on change over time
4)	Self-reports are susceptible to social desirability (particularly susceptible to sensitive topics)
5)	Self-reports are susceptible to demand characteristics
6)	Self-reports are susceptible to response set
7)	Self-reports are susceptible to response shift bias (recalibration of standards (Howard, 1980)
8)	Individuals have limited ability to access nonconscious processes. Self-reports provide responses to which participants have no ability to veridically monitor or report (e.g., attention, motivation activation, sympathetic nervous system arousal); deficient self-knowledge/psychological mindedness
9)	Self-reports may be susceptible to the satisficing-heuristic, meaning that individuals choose a satisfactory rather than veridical or optimal option (Simon, 1956)
10)	Self-reports may provide answers even if there was a misunderstanding of questions
11)	Self-report during exposure requires attention switching (from primary task of attending to message to secondary task for providing some sort of rating)

Neuromarketing and the Embodied Mind

Having defined neuromarketing and provided several relative advantages of a neuromarketing approach to research, we now lay out some fundamental theoretical propositions that guide its use. The first and most important proposition underlying a neuromarketing approach is that the psychological processes under study are

embodied phenomena. This means that the mental experiences that occur when a person is exposed to marketing communications (e.g., perception, attention, attitude, emotion) are grounded in the physical activity of the brain and the other physical systems it governs within the human organism. In short, psychological experiences occur as part of an embodied physical system, thereby allowing the researcher to assess cognitive and emotional processes via physiological measurement. Indeed, it is this foundational assumption that allows the physiological responses specified later in this chapter to serve as valid indicators of psychological processes and effects.

The second fundamental proposition of the neuromarketing approach is that the embodied mind functions as a motivated information processing system. This means that the aforementioned mental experiences that occur when we process information are grounded in a biological system that is motivated, first and foremost, to promote our survival. This motivational system enables us to efficiently process motivationally relevant stimuli—objects in our environment that either promote or threaten survival—and mobilize the organism to engage in the appropriate behavior. This system is believed to consist of two subsystems: the appetitive motivational system and the aversive motivational system. The appetitive system governs behavior associated with approaching beneficial, opportunistic, and rewarding stimuli (e.g., food, shelter, mates) while the aversive system governs behavior associated with avoiding threatening stimuli (e.g., predators, noxiousness) (Bradley & Lang, 2013).

The third fundamental proposition of the neuromarketing approach is that the embodied brain and its associated systems, like the rest of the human organism, has evolved over the history of our species to facilitate survival. The same neural mechanisms that have guided our responses to appetitive and aversive stimuli in the physical environment are similarly deployed when we are exposed to mediated stimuli. In other words, media often equal reality as far as our evolved, embodied brain and motivational systems are concerned (Reeves & Nass, 1996).

The net result of these assumptions is that our embodied, evolved brain and the physical systems it governs respond reliably and systematically to mediated stimuli that activate fundamental motivational systems. The neuromarketing approach uses these psychophysiological responses to illuminate the psychological experiences that occur when a person is exposed to marketing communication. The following sections of this chapter describe some of the fundamental tools of the consumer neuroscience approach to marketing communication.

Central Nervous System Measures of Cognitive Processing of Media

In the following section, we review central nervous system (CNS) measures of cognitive processing of media. In brief, CNS measures are those that directly capture brain-based

cognitive processes related to attention, perception, and memory. Autonomic nervous systems (ANS) measures capture similar cognitive processes; however, these responses are recorded from the peripheral nervous system (e.g., heart rate). CNS measures are discussed next.

Electroencephalography (EEG)

Electroencephalography (EEG) techniques record electrical activity from the brain via the surface of the scalp. Due to high resolution for time-based measurement, the primary advantage of EEG to marketers and researchers are uncovering psychological processes as they occur over time. This is advantageous, for example, when an advertiser desires to know which points in an advertisement (e.g., presentation of the brand logo) generate positive emotion and/or attention. Correspondingly, EEG technologies are available and accessible to researchers and practitioners. Some entry-level manufacturers/distributors of these devices for research include EMOTIV and BIOPAC (BIOPAC, 2024; EMOTIV, 2004). Consumer research companies, such as Neurensics, employ EEG techniques in market research to enhance the generation of consumer insights (Neurensics, n.d.a).

Increasing availability of EEG to marketers has resulted in insights into consumer behavior that are unable to be obtained via traditional research measures such as self-reports. For example, Pozharliev and colleagues (2015) demonstrated that brain response associated with emotional arousal was enhanced when participants viewed advertisements for luxury brands in the presence of other people. Other research using EEG found that negative emotion to mid-roll advertisements decreased with each subsequent presentation and that bottom-up attention facilitated information encoding of pre- and post-roll advertisements (Lee et al., 2024).

These, and other, EEG studies commonly employ either event-related potential (ERP) or frequency band techniques to examine consumers' neural responses over time. The ERP technique addresses systematic fluctuations in the brain's electrical activity in response to a particular stimulus, or "event." Researchers examine these time-locked positive and negative deflections, called ERPs, to infer psychological processes. Common ERP naming conventions first include whether the deflection is positive (P) or negative (N) and then either the temporal order (3) or time in ms (300) in which the ERP occurred. A positive deflection at around 300 ms (also, conveniently, the third positive deflection) is referred to as either P300 or P3. The P3 reflects "context updating" and is enhanced for novel stimuli in an oddball task. Other ERPs do not follow this naming convention (e.g., the error-related negativity—ERN—or the late positive potential—LPP) (Luck, 2014; Read & Innis, 2018).

While ERPs are more feasible to investigate in the context of static stimuli, analyzing frequency band activity is appropriate for examining neural processes in response

to dynamic stimuli over time. Each band of frequencies of brain activity in the EEG is associated with some psychological phenomenon. Those most often investigated in marketing are alpha (8–13 Hz), associated with boredom or relaxation, and beta (14–30 Hz), associated with active cognitive processing (Read et al., 2024). Alpha blocking occurs when faster beta waves replace alpha waves and is used to assess attention to an external stimulus (Hartoyo et al., 2020), such as marketing communication. This pattern of a decline in boredom-related waves with an increase in active processing waves can indicate when a video ad, for example, piques a consumer's interest.

One important limitation of EEG is that of spatial resolution. While EEG is an ideal tool for telling us *when* something happens in the brain, it is limited in its ability to tell us *where* something happens in the brain. For this type of investigation, we turn to another consumer neuroscience tool.

Functional Magnetic Resonance Imaging (fMRI)

Functional magnetic resonance imaging (fMRI) indicates the presence of oxygenated blood—referred to as the blood oxygenation level dependent (BOLD) signal—in regions of the brain to provide insight into where brain activity occurs during particular tasks. Compared to EEG, fMRI is less accessible to marketing researchers and practitioners due to the high cost of obtaining and maintaining an fMRI system, although access may be available to researchers through interdisciplinary units within the university setting (Read et al., 2024). Consequently, Neurensics presents itself as one of the only consumer neuroscience companies in the world using this technology (Neurensics, n.d.b).

Despite challenges to access, fMRI has presented important insights into consumer behavior. Falk et al. (2012), for example, used fMRI data to predict population-level consumer behavior from data collected from a small sample. Neurensics highlights how they used fMRI data to provide insight into nonconscious positive and negative emotion to help mobile network provider, Tele2, improve its brand image through advertising. The associated brand campaign, “Not because you have to. But because you can.” won a Silver Effie Award, a prestigious marketing and advertising recognition (Neurensics, n.d.c.).

Neural regions in fMRI data are typically investigated as regions of interest (ROIs) determined by consulting an anatomical atlas and/or prior research. Functional ROIs, on the other hand, are determined by investigating brain regions activated during an experimental task (Falk et al., 2015). As a method, fMRI provides excellent spatial resolution, and even useful time resolution (although EEG excels at this), but its prohibitive cost compared to other consumer neuroscience tools limits its accessibility to marketing researchers and practitioners.

Measures of Cognitive Processing of Media

As reviewed insofar, CNS measures directly record cognitive activity from the brain. Below, we review autonomic nervous system (ANS) measures of cognitive processing of media, which include heart rate, electrodermal activity, among others. Generally, these measures are less invasive and less expensive relative to the time and equipment needed to record CNS responses. Additionally, autonomic measures also provide excellent temporal resolution, allowing the researcher to time-lock cognitive and emotional responses to specific message copy points. ANS measures are discussed next.

Heart Rate

Heart rate measurement has been widely adopted in the field of communication—and by extension the field of marketing—as a *correlate* of cognitive resources allocated to encoding mediated content (Clayton & Myrick, 2025; Lang, 1990, 1994; Potter & Bolls, 2012; Read et al., 2024; Wise, 2017). Heart rate is measured with the electrocardiograph (ECG), a non-expensive and non-invasive recording technique. ECG recording provides excellent time resolution (often in milliseconds), which allows the researcher to examine consumers' attentional allocation second-by-second during exposure to marketing communication (Potter et al., 2024).

Decades of biometric and neuroscience research have shown that the heart *decelerates*—reflective of increased attention (Lang, 1994)—via activation of the parasympathetic nervous system (i.e., the system involved in rest, repair, and enjoyment) to novel mediated information. This is the case when a consumer has an orienting response (i.e., the “what is it?” response) (Potter et al., 2008; Thorson & Lang, 1992) or believes message content provides opportunities and rewards (Lang, 2006, 2009).

Research has further shown that the heart *accelerates*—reflective of less attention—via sympathetic nervous system activation (i.e., the system associated with the four Fs: freeze, flight, fight, flirt) during exposure to highly aversive message content (Clayton et al., 2017a, 2017b; Leshner et al., 2011, 2018). Moreover, Clayton et al. (2019) and Clayton (2022) demonstrated that the directionality of a defensive response (fight or flight) can be identified via self-report measures (i.e., counterarguing scales) when heart rate acceleration is observed during exposure to highly negative marketing communication. Heart rate has also been found to accelerate when consumers engage in internal mental processing including when consumers actively socially compare themselves to fashion models presented in retail advertisements (Clayton et al., 2017c), reminisce during radio advertisements following nostalgic music (Clayton, 2021), engage in mental imagery during exposure to high imagery radio advertisements (Bolls, 2002), and when consumers actively counterargue a message (Clayton, 2022; Wang & Lang, 2012). Procedurally, measuring heart rate often involves placing electrocardiogram electrodes securely on

each forearm with a ground electrode placed on the consumer's wrist. In settings where the participant will be mobile (e.g., virtual reality), it is better to place electrodes on a consumer's torso. The electrodes are often pre-gelled and disposable. Amplification settings allow the researcher to distinguish the ECG signal from other potential electrical sources (i.e., electrical noise). The ECG signal can be amplified using a gain setting of 5 K with a low pass filter of 35 Hz and a high pass filter of 1 Hz (Potter & Bolls, 2012). Most often, heart rate is converted from milliseconds (ms) between R-spikes within the QRS complex to beats per minute (BPM) (Keene et al., 2017), which reflects two consecutive heartbeats. This value is then used to calculate the time period between heartbeats, also known as the inter-beat interval (IBI). Heart rate is considered the number of IBIs in a 60-second period, expressed in beats per minute.

To minimize carryover effects, the researcher may subtract each second of heart rate during message exposure from a predetermined baseline period. It is these "change scores" that are analyzed. The researcher can opt for orienting response assessment or content-specific assessment (i.e., phasic analysis) or the researcher might want to examine variation in heart rate – and thus, cognitive effort – for the length of the entire message (i.e., tonic analysis).

Measurement of heart rate can provide insights regarding how attention varies across message exposure and during specific message points. It is important to note, however, that heart rate is a *correlate* of attention and should always be used in conjunction with other measures, including post-message self-report and memory tasks (Clayton, 2023; Clayton & Myrick, 2025). Heart rate is not a measure of whether consumers will remember content, nor is it an indicator of their attitudes and behavioral intentions (Potter & Bolls, 2012). Indeed, consumers can allocate attention to a marketing message being studied, but that does not create a 1:1 ratio for positive attitudes or intentions to purchase the product or service being promoted.

Eye Tracking

Eye-tracking research is gaining popularity among marketing researchers due to its decreasing cost and increasing flexibility. This method is valuable for studying various aspects of visual behavior, allowing researchers to better understand how people direct and sustain their attention during exposure to advertisements and other marketing communications.

The logic of eye tracking as a valid indicator of visual attention is historically rooted in the eye-mind hypothesis, which simply states that where a person looks and what they are thinking about are highly correlated (Just & Carpenter, 1976). Attention is seen as a mechanism that has evolved over the course of human history, enabling us to focus on motivationally relevant stimuli, such as threats or rewards (Cosmides & Tooby, 2013). Prominent models of attention and cognition theorize that humans have limited

cognitive capacity, selecting certain stimuli for processing at the expense of others (e.g., Lang, 2017).

Eye-tracking measures are typically used to operationalize visual attention as a dependent variable tied to specific stimuli. Marketing researchers can also use eye tracking to explore adjacent psychological concepts, such as perception, learning, and memory. While many different types of eye trackers are available today, the underlying mechanics of eye-tracking data are rather simple: An eye-tracker captures gaze location in a two-dimensional space (x- and y-coordinates) at a specific point in time. The most commonly used eye-tracking measures are fixation-based measures derived from these data. They include measures like *fixation count*, the number of times a participants' eyes are fixated on an area of interest (AOI), *time to first fixation* (TTFF), the time it takes for the first AOI is visited, and *dwell time*, the amount of fixation time on a specific area of interest (AOI) in the marketing media being studied. Another emerging category of eye-tracking data is *scanpath analysis*, in which the sequence of fixations during exposure is studied and linked with downstream outcomes like comprehension and memory.

Comprehensive reviews by Duchowski (2017) and King et al. (2019) provide a deeper dive into the use of eye tracking in media research. In sum, eye tracking provides a nuanced understanding of how individuals interact with visual messages, offering a critical tool for both academic and applied marketing research.

Measures of Emotional Processing of Media

While the CNS and ANS measures described above provide valuable insight into cognitive processing of media, such measures do not necessarily reflect audiences' emotional responses. Thus, measures of arousal and emotion can be triangulated with measures of cognitive processing to holistically assess both cognitive and emotional responses to marketing communications. Measures of arousal and emotion are described next.

Electrodermal Activity (EDA)

Electrodermal activity (EDA) is a non-invasive measure of autonomic sympathetic arousal that can be recorded during exposure to marketing communication. EDA is sometimes referred to in the literature as electrodermal response (EDR), skin conductance (SC), and galvanic skin response (GSR) (Clayton, 2023). EDA originates from the autonomic nervous system and is solely driven by activation of the sympathetic nervous system (Boucsein, 1992). EDA refers to the ease at which electricity moves across the skin (Potter & Bolls, 2020). Activated sweat glands result in increased moisture that secrete through pores of the skin, which results in greater electrical flow (Stern et al., 2001). Increased skin conductance and, therefore, increased electrical flow, occurs primarily

for thermoregulation (Boucsein, 1992), but it also occurs when individuals are emotionally aroused, including during exposure to a marketing message (Potter & Bolls, 2020).

Procedurally, the researcher interested in EDA measurement uses Ag/AgCl (silver/silver chloride) sensors that have a 1 cm² measurement site, which are placed with either reusable snap-on Velcro straps or with an adhesive collar placed on consumers' non-dominant hand or on the palmar surface of the foot (Potter & Bolls, 2012). Next, a small electrical voltage (.5 v) is sent to the electrodes. Electrical conductance increases between the two electrodes as sweat is secreted and fills the ducts via sympathetic nervous system activity (Potter & Bolls, 2020; Stern et al., 2001). The electrical resistance between the two electrodes is typically measured in micro-Siemens (μ S).

The EDA signal consists of two main components: tonic and phasic. A slowly varying tonic or baseline level is referred to as skin conductivity level (SCL). The phasic component is referred to as skin conductance responses (SCRs). SCRs include reactions to specific eliciting stimuli (SCR peaks) and non-specific skin conductance responses (NS-SCRs). SCRs are important in emotional quantification because they measure the level of arousal an individual experiences in response to a known stimulus (Potter & Bolls, 2012). SCR metrics include latency, amplitude, rise time, and recovery time (Kreibig, 2010), while SCL can show increases and decreases in autonomic arousal across the duration of exposure to a marketing message (Clayton, 2023).

EDA is an ideal measure to track emotional arousal during exposure to marketing communication. However, EDA is not able to reveal the valence of the emotional response. Thus, as we noted earlier, it is important to triangulate EDA with other measures, including self-reported arousal, valence, and other psychophysiological indicators of emotion.

Facial Electromyography (fEMG)

Facial electromyography (fEMG) is the measurement of electrical activity in consumers' facial muscles, typically used to indicate positive and negative emotional valence during exposure to a marketing message (Clayton, 2023; Ekman & Friesen, 1976; Fridlund & Cacioppo, 1986; Lang et al., 1990; Potter & Bolls, 2012, 2020). The primary muscles analyzed as correlates of emotional valence include the corrugator supercilii (CS) region, the zygomaticus muscle (ZM) region, and orbicularis oculi (OO) muscle region, among others (Fridlund & Cacioppo, 1986).

CS is located above the eyebrow and toward the nose. Activation or furrowing of this muscle is associated with negative emotional valence (Fridlund & Cacioppo, 1986). Activation of CS is inhibited during exposure to positive information or message content (Ekman & Friesen, 1978). Most often, however, communication scholars have recorded this muscle as an indicator of a negative emotional experience and aversive motivational activation during media exposure (Clayton, 2023; Potter & Bolls, 2012; Read, 2020).

The ZM is located on the cheek and is positioned even with the base of the nose and extending to the outer edge of the eye (Fridlund & Cacioppo, 1986). The ZM is primarily activated during smiling and, therefore, is associated with positive emotional valence and appetitive motivational activation during media exposure (Clayton, 2023; Potter & Bolls, 2012).

OO is located on the lower outer corner of the eyelid just below the pupil. OO is also primarily activated during the experience of positive emotional valence and appetitive motivational activation (Fridlund & Cacioppo, 1986). Moreover, when OO and ZY are measured and combined, these two fEMG regions comprise the authentic smile, also known as the Duchenne smile (Ekman, 1992; Ekman & Friesen, 1978; Fridlund & Cacioppo, 1986).

Procedurally, measuring fEMG involves recording the electrical activity of facial muscles to assess emotional responses using surface electromyography (EMG) electrodes. fEMG measurement is extremely sensitive to bioelectrical activity that may occur automatically and without awareness. Indeed, fEMG responses often occur without any physical observation. To record fEMG, the researcher may use reusable electrodes with disposable adhesive electrode collars or single-use EMG electrodes that are pre-gelled for ease of use (Potter & Bolls, 2012). The EMG sensors are carefully applied to the facial region of interest. The fEMG recordings are typically measured in microvolts (μV) and undergo several processing steps, including amplification, filtering, and rectification to clean the data from noise and prepare it for analysis (see Clayton, 2023; Read, 2018). Much like heart rate and skin conductivity, the researcher can analyze changes in muscle activity by calculating change scores from a baseline resting period. fEMG data can be analyzed for both phasic activity, which shows rapid changes in response to stimuli, and tonically reflecting sustained muscle activity (Hess & Kleck, 1990).

Historically, fEMG has provided researchers insights into how emotional valence varies during exposure to some known stimulus. In fact, Hazlett and Hazlett (1999) were the first to publish marketing work using fEMG measures as a “way to get beyond the limitations and biases that often plague self-report” (pp. 19–20). However, that is not to say marketing researchers should abandon traditional self-report measures of emotion and valence. As described elsewhere (see Clayton, 2023; Mauss & Robinson, 2010), fEMG does not provide evidence of discrete (i.e., distinct specific emotions) during message exposure (Nabi, 2010). Therefore, the marketing researcher who triangulates fEMG data with self-report batteries of emotion will be best equipped to examine emotional responses to media messages holistically and to parse specific responses.

Facial Expression Analysis (FEA)

Humans can generally infer other people’s emotional states by seeing their facial expression. Based on Darwin’s universality hypothesis, humans can accurately classify emotions

based on recognizing faces, and a major assumption is that emotions are universal (and adaptive). The numerous muscles that are attached to and move facial skin create facial expressions. Almost all facial muscles are triggered by the facial nerve (except the upper eyelid). Research supports the notion that facial expressions and emotions are closely intertwined (e.g., Strack et al., 1988).

Ekman and Friesen and his colleagues (1976, 1978, 2002) developed the Facial Action Code (FAC) to classify a wide range of expressions. The FAC was derived from analyses of facial movements and can describe any facial movement in terms of anatomically based action units (AUs), which serve as the basis for the facial action coding system (FACS). Each AU corresponds to an individual face muscle or muscle group. For many years, researchers would undertake intensive and complex training to code expressions.

Fortunately, facial expression analysis has moved from human coding to reliable automatic classification based on a webcam and software that applies algorithms. Algorithms analyze the patterns of AU activations and assess the intensity of discrete (i.e., distinct specific emotions such as fear or joy) and dimensional (i.e., positive or negative valence) emotional responses. FACS scores contain intensity ratings, which assess the extent to which an emotion is expressed, making facial expression analysis a relatively easy and fast way to assess emotional response—both discrete and dimensional classifications of emotions.

Depending on the software used, automated FEA can detect head orientation (yaw, pitch, roll), facial landmarks, 6–7 discrete emotions, and emotional valence. Software can also vary depending on the number of AUs they collect, and the threshold methods they use to indicate the likelihood of an emotion being activated. Careful attention must be paid to the particular software one uses, as well as the methods for computing facial expressions. For example, some software provides raw data from the facial coding algorithm that represents a “confidence score,” which indicates the probability of detecting a particular facial expression at a specific moment. One benefit of these data is that they provide excellent temporal resolution as responses can be collected over time during message exposure (typically in milliseconds). These data can then be interpreted as indicating an emotional shift tied to the corresponding message feature. The strength of confidence can also be filtered so that the system counts only those scores that the algorithm shows are above a certain confidence threshold (Leshner, Clayton, & Seo, *in press*).

Typically, FEA responses are recorded via a participant’s webcam or a camera built into the participant’s monitor. Software that records FEA is rapidly developing. For example, Affectiva’s AFFDEX (Affectiva, n.d.) uses AI to record expressed facial emotions to media stimuli. Recently developed software permits the recording of FEA online using the participants’ camera (e.g., iMotions, 2024), allowing researchers to collect FEA data across many participants.

Ethical Considerations

Despite, or perhaps because of, the exciting potential for consumer neuroscience tools to contribute to our understanding of marketing and consumer processes, it is important to consider the ethical implications of applying neuroscience tools to questions of consumer attitudes and behavior. As Spider-Man learned, “with great power there must also come—great responsibility” (Lee, 1962). Ariely and Berns (2011) highlight ethical concerns about consumer neuroscience, including those concerning the privacy of thoughts and personal preferences, potential for exploitation of vulnerable people or groups, and a lack of regulation, among others. Recent work in neuroethics expands upon these concerns while highlighting the unique capability of neuroscientific tools to provide insight into consumer processes with a precision that would not be possible without neuroscience, including those motivating consumer behavior and improving marketers’ predictions (Clark, 2020; Ienca & Starke, 2024).

Some scholars counter that many of the ethical issues surrounding consumer neuroscience are not distinctive from those of consumer research, broadly. Others argue that many of the ethical quandaries applied to consumer neuroscience “turn out to be unrealistic, because [of assumptions that] neuromarketing has powers that it cannot obtain in the near future” (pp. 802–803; Stanton et al., 2017). Protecting the autonomy of research participants is an important ethical consideration, given that consumers must be aware of factors that influence them if they want to retain control over their choices and consent to their involvement in research. Stanton et al. (2017) note that we should be cautious about conflating consciousness and control, stating that although “consumers are unaware of factors that influence their choice, . . . they still make free choices” (p. 805). This argument does not mean that consumer neuroscience techniques are without ethical concerns, only that many of the ethical concerns could be somewhat different from those commonly cited in consumer research.

Some of these concerns reflect ethical protections in place for research in the academy versus the industry. Clark (2020), for example, proposes the idea of tiered consent, such that participants can approve some uses of their data (e.g., academic publication) but not others (e.g., commercial use). Other concerns include ways to handle the detection of neurological anomalies in commercial data collection. Clark (2020) provides an example of how to address the possibility of incidental findings in the informed consent statement that participants sign.

On the other hand, scholars posit that because much information is processed automatically and emotion-driven, there is a potential for consumer choices to be unduly influenced by marketers (Clark, 2020). Tournas and Johnson (2024) argue that marketers can use biometric data to constrain consumer choices in ways that influence behavior and limit consumers’ autonomy. Compared to traditional (non-neuroscientific) marketing techniques, consumer neuroscience data introduce special ethical concerns. Physi-

ological data, for example, are especially sensitive in that they may detect information that consumers do not want to reveal. Thus, those using consumer neuroscience tools have a responsibility to adhere to ethical practices (Clark, 2020).

Other concerns revolve around different goals and practices surrounding the use of neuroscientific tools in the academy versus the industry, methodological rigor, transparency, quality certification, and privacy (Stanton et al., 2017). Consumer neuroscience tools are increasingly available to the public. Direct-to-consumer (DTC) neurotechnologies and wearable biometric devices can provide physiological data to marketers on a large scale. Tournas and Johnson (2024) highlight concerns that marketers' use of data from these devices present ethical quandaries in terms of privacy, consumer autonomy, and personality and identity. While university Institutional Review Boards (IRBs) are responsible for overseeing ethical compliance in academic research, commercial researchers have little oversight—with the exception of those using fMRI (Clark, 2020). Organizations such as the Neuromarketing Science and Business Association (NMSBA, n.d.) to provide standards for consumer neuroscience in the industry, and many consumer neuroscience companies subscribe to this code. However, the closure of the NMSBA in 2026 presents a gap to be filled in terms of ethical oversight of consumer neuroscience research.

Conclusion

This chapter introduced a consumer neuroscience approach to marketing research. We defined neuromarketing and presented ways in which it might complement other methods used in marketing research. The consumer neuroscience approach is grounded in unique foundational assumptions about the relationship between physiological and psychological experience during exposure to marketing media. While the mechanics of employing a neuroscience approach may change with advances in signal acquisition and processing, the underlying ideas behind this approach are consistent with a fundamental understanding of the different systems within the human organism.

We organized this chapter according to the different physiological systems that underlie the key psychological phenomena of interest in marketing research. We included measures for both the central and peripheral nervous systems, categorized by cognitive and emotional measures. We also discussed some primary ethical considerations about using neuroscience tools to measure consumer responses. This chapter provides an overarching introduction to the consumer neuroscience approach and neuromarketing tools. The hope is that both academic and industry researchers, as well as students, find this chapter informative.

References

- Affectiva. (n.d.). Affectiva emotion AI software [Computer software]. Smart Eye. <https://www.affectiva.com/>
- Ariely, Dan, & Berns, Gregory S. (2010). Neuromarketing: The hope and hype of neuroimaging in business. *Nature Reviews Neuroscience*, 11(4), 284–292. doi.org/10.1038/nrn2795
- Biopac (2024). Neuromarketing World Forum 2024. Retrieved from <https://www.biopac.com/events/nmwf-2024/>
- Bolls, Paul D. (2002). I can hear you, but can I see you? The use of visual cognition during exposure to high-imagery radio advertisements. *Communication Research*, 29(5), 537–563. doi.org/10.1177/009365002236194
- Boucsein, Wolfram (1992). *Electrodermal activity*. Plenum.
- Clark, Kimberly Rose (2020). A field with a view: Ethical considerations for the fields of consumer neuroscience and neuromarketing. In Imre Bárd and Elisabeth Hildt (Eds.), *Neuroethics and bioethics: Ethical dimensions of commercial and DIY neurotechnologies* (Vol. 3). Elsevier. doi.org/10.1016/bs.dnb.2020.03.002
- Clayton, Russell B. (2021). Thinking about the past? Examining the effects of temporal comparisons and reminiscing on cognitive processing of music and radio advertisements. *Journal of Broadcasting & Electronic Media*, 65(1), 88–110. doi.org/10.1080/08838151.2021.1897820
- Clayton, Russell B. (2022). On the psychophysiological and defensive nature of psychological reactance theory. *Journal of Communication*, 72(4), 461–475. doi.org/10.1093/joc/jqac016
- Clayton, Russell B. (2023). Psychophysiological responses to using digital media. In Robin L. Nabi & Jessica Gall Myrick (Eds.), *Emotions in the Digital World: Exploring Affective Experience and Expression in Online Interactions* (pp. 55–75). Oxford University Press.
- Clayton, Russell B., Lang, Annie, Leshner, Glenn, & Quick, Brian L. (2019). Who fights, who flees? An integration of the LC4MP and psychological reactance theory. *Media Psychology*, 22(4) 545–571. doi.org 10.1080/15213269.2018.1476157
- Clayton, Russell B., Leshner, Glenn, Bolls, Paul D., & Thorson, Esther (2017a). Discard the smoking cues—Keep the disgust: An investigation of tobacco smokers' motivated processing of anti-tobacco commercials. *Health Communication*, 32, 1319–1330. doi:10.1080/10410236.2016.1220042
- Clayton, Russell B., Leshner, Glenn, Tomko, Rachel L., Trull, Timothy J., & Piasecki, Thomas M. (2017b). Countering craving with disgust images: Examining nicotine withdrawn smokers' motivated message processing of anti-tobacco public service announcements. *Journal of Health Communication*, 22(3), 254–261. doi.org/10.1080/10810730.2016.1268222
- Clayton, R. B., & Myrick, J. G. (2025). “What can the heart tell us about thinking?” A three-decade review of heart rate measurement and its future applications to advertising research. *Journal of Advertising*, 54(5), 621–636.
- Clayton, Russell B., Ridgway, Jessica L., & Hendrickse, Joshua (2017c). Is plus size equal? The positive impact of average and plus-sized media fashion models on women's cognitive resource allocation, social comparisons, and body satisfaction. *Communication Monographs*, 84(3), 406–422. doi.org/10.1080/10810730.2016.1268222
- Cosmides, Leda, & Tooby, John (2013). Evolutionary psychology: New perspectives on cognition and motivation. *Annual Review of Psychology*, 64(1), 201–229. doi.org/10.1146/annurev.psych.121208.131628
- Duchowski, Andrew T. (2017). *Eye tracking methodology: Theory and practice*. Springer.
- Ekman, Paul (1992). Are there basic emotions? *Psychological Review*, 99, 550–553. doi.org/10.1037/0033-295x.99.3.550
- Ekman, Paul & Friesen, Wallace V. (1976). Measuring facial movement. *Environmental Psychology and Nonverbal Behavior* 1(1), 56–75. doi.org/10.1007/BF01115465
- Ekman, Paul, & Friesen, Wallace V. (1978). *Facial Action Coding System: A technique for the measurement of facial movement*. Consulting Psychologists Press. doi.org/10.1037/t27734-000

- Ekman, Paul, Friesen, Wallace V., & Hager, Joseph C. (2002). *Facial Action Coding System*. Manual and Investigator's Guide, Research Nexus.
- Falk, Emily B., Berkman, Elliot T., & Lieberman, Matthew D. (2012). From neural responses to population behavior: Neural focus group predicts population-level media effects. *Psychological Science*, 23(5), 439–445. doi.org/10.1177/0956797611434964
- Falk, Emily B., Cascio, Christopher N., & Coronel, Jason C. (2015). Neural prediction of communication-relevant outcomes. *Communication Methods and Measures*, 9(1-2), 30–54. doi.org/10.1080/19312458.2014.999750
- Fridlund, Alan J., & Cacioppo, John T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, 23, 567–589. doi.org/10.1111/j.1469-8986.1986.tb00676.x
- Emotiv (n.d.). Neuromarketing: Using EMOTIV's portable EEG technology in market research. Retrieved from <https://www.emotiv.com/blogs/news/neuromarketing-in-consumer-behavior>
- Harrell, Eben (2019). Neuromarketing: What you need to know. *Harvard Business Review*. <https://hbr.org/2019/01/neuromarketing-what-you-need-to-know>
- Hartoyo, Agus, Cadusch, Peter J., Liley, David T. J., & Hicks, Damien G. (2020). Inferring a simple mechanism for alpha-blocking by fitting a neural population model to EEG spectra. *PLoS Computational Biology*, 16(4), e1007662. doi.org/10.1371/journal.pcbi.1007662
- Hazlett, Richard L., & Hazlett, Sasha Yassky (1999). Emotional response to television commercials: Facial EMG vs. self-report. *Journal of Advertising Research*, 39, 7–23.
- Hess, Ursula, & Kleck, Robert E. (1990). Differentiating emotion elicited and deliberate emotional facial expressions. *European Journal of Social Psychology*, 20(5), 369–385. doi.org/10.1002/ejsp.2420200502
- Howard, George S. (1980). Response-shift bias: A problem in evaluating interventions with pre/post self-reports. *Evaluation Review*, 41, 93–106. doi.org/10.1177/0193841x8000400105
- iMotions. (2024). iMotions 10.1.x [Computer software]. iMotions A/S. <https://imotions.com>.
- Ienca, Marcello, & Starke, Georg (Eds.). (2024). *Developments in neuroethics and bioethics: Brains and machines: Toward a unified ethics of AI and neuroscience (Vol. 7)*. Academic Press. <https://www.sciencedirect.com/bookseries/developments-in-neuroethics-and-bioethics/vol/7/suppl/C>
- Just, Marcel A., & Carpenter, Patricia A. (1976). Eye fixations and cognitive processes. *Cognitive Psychology*, 8(4), 441–480. doi.org/10.1016/0010-0285(76)90015-3
- Keene, Justin Robert, Clayton, Russell. B., Berke, Collin K., Loof, Travis, & Bolts, Paul D. (2017). On the use of beats-per-minute and interbeat interval in the analysis of cardiac responses to mediated messages. *Communication Research Reports*, 34(3), 265–274. doi.org/10.1080/08824096.2017.1334640
- King, Andy J., Bol, Nadine, Cummins, R. Glenn, & John, Kevin K. (2019). Improving visual behavior research in communication science: An overview, review, and reporting recommendations for using eye-tracking methods. *Communication Methods and Measures*, 13(3), 149–177. doi.org/10.1080/19312458.2018.1558194
- Kreibig Sylvia D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, 84(3), 394–421. doi.org/10.1016/j.biopsycho.2010.03.010
- Lang, Annie (1990). Involuntary attention and physiological arousal evoked by structural features and emotional content in TV commercials. *Communication Research*, 17(3), 275–299. doi.org/10.1177/009365090017003001
- Lang, Annie (1994). *Measuring psychological responses to media*. Lawrence Erlbaum Associates, Inc.
- Lang, Annie (2006). Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication*, 56(1) 57–80. doi.org/10.1111/j.1460-2466.2006.00283.x
- Lang, Annie (2009). The limited capacity model of motivated mediated message processing. In Robin L. Nabi & Mary Beth Oliver (Eds.), *The SAGE Handbook of Media Processes and Effects* (pp. 193–204). Sage Publications.
- Lang, Annie (2017). Limited capacity model of motivated mediated message processing (LC4MP). In Patrick Rössler (Ed.), *The International Encyclopedia of Media Effects* (pp. 1–9). Wiley Blackwell. doi.org/10.1002/9781118783764.wbieme0077

- Lang, Peter J., & Bradley, Margaret M. (2013). Appetitive and defensive motivation: Goal-directed or goal-determined? *Emotion review: Journal of the International Society for Research on Emotion*, 5(3), 230–234. doi.org/10.1177/1754073913477511
- Lang, Peter J., Bradley, Margaret M., & Cuthbert, Bruce N. (1990). Emotion, attention, and the startle reflex. *Psychological Review*, 97, 377–395.
- Lee, Seungji, Kim, Jooyoung, Read, Glenna. L., & Kim, Sung-Phil (2024). The effects of in-stream video advertising on ad information encoding: A neurophysiological study. *Journal of Advertising*, 53(3), 342–356. doi.org/10.1080/00913367.2023.2222782
- Leshner, Glenn, Bolls, Paul, & Wise, Kevin (2011). Motivated processing of fear appeal and disgust images in televised anti-tobacco ads. *Journal of Media Psychology*, 23(2), 77–89. doi.org/10.1027/1864-1105/a000037
- Leshner, Glenn, Clayton, Russell B., Bolls, Paul D., & Bhandari, Manu (2018). Deceived, disgusted, and defensive: Motivated processing of anti-tobacco advertisements. *Health Communication*, 33(10), 1223–1232. doi.org/10.1080/10410236.2017.1350908
- Leshner, Glenn, Clayton, Russell B., & Seo, Jinhee (in press). Exploring media psychophysiology: Conceptual, theoretical, and methodological considerations. In L. J. Shen (Ed.), *Quantitative Research Methods in Communication Science*. De Gruyter Mouton.
- Luck, Steven. J. (2014). *An introduction to the event-related potential technique* (2nd ed.). MIT Press.
- Mauss, Iris B., & Robinson, Michael D. (2010). Measures of emotion: A review. In Jan De Houwer & Dirk Hermans (Eds.), *Cognition and Emotion: Reviews of Current Research and Theories* (pp. 99–127). Psychology Press.
- Nabi, Robin L. (2010). The case for emphasizing discrete emotions in communication research. *Communication Monographs*, 77, 153–159. doi.org/10.1080/03637751003790444
- NMSBA (n.d.) What is neuromarketing?. Retrieved from <https://www.nmsba.com/neuromarketing/what-is-neuromarketing>
- Neurensics (n.d.a). EEG in neuromarketing. Retrieved from <https://www.neurensics.com/en/eeg-in-neuromarketing>
- Neurensics (n.d.b). fMRI in Neuromarketing. Retrieved from <https://www.neurensics.com/en/fmri-in-neuromarketing>
- Neurensics (n.d.c). How to win an award for effective advertising? Retrieved from <https://www.neurensics.com/en/case-tele2-how-to-win-an-award-for-effective-advertising>
- Potter, Robert F., & Bolls, Paul D. (2012). *Psychophysiological measurement and meaning: Cognitive and emotional processing of media*. Routledge. doi.org/10.4324/9780203181027
- Potter, Robert F., & Bolls, Paul D. (2020). Investigating communication using peripheral nervous system measurement. In Kory Floyd & René Weber (Eds.), *The Handbook of Communication Science and Biology* (pp. 266–278). Routledge. doi.org/10.4324/9781351235587
- Potter, Robert F., Lang, Annie, & Bolls, Paul D. (2008). Identifying structural features of audio: Orienting responses during radio messages and their impact on recognition. *Journal of Media Psychology: Theories, Methods, and Applications*, 20(4), 168–177. doi.org/10.1027/1864-1105.20.4.168
- Potter, Robert F., Ni, Yuqian, & Marlet, Ramon Q. (2024). Four decades of biological measurement advancing mediated communication theory: A review of literature from 1980–2020. *Annals of the International Communication Association*, 48(4), 415–435. doi.org/10.1080/23808985.2024.2391308
- Pozharliev, Rumen, Verbeke, Willem J. M. I., van Strien, Jan W., & Bagozzi, Richard P. (2015). Merely being with you increases my attention to luxury products: Using EEG to understand consumers' emotional experience with luxury branded products. *Journal of Marketing Research*, 52(4), 546–558. doi.org/10.1509/jmr.13.0560
- PQ Media (2025). Global ad & marketing spend surged 8.7% in 2024, fueled by influx of even-year political and Olympics media buys & double-digit growth in 29 of 45 media channel. PQ Media via Statista. <https://www.prweb.com/releases/global-ad-marketing-spend-surged-8-7-in-2024-fueled-by-influx-of-even-year-political-olympics-media-buys-double-digit-growth-in-29-of-45-digital-media-channel-302364323.html>

- Read, Glenna L. (2018). Facial electromyography (EMG). In Jörg Matthes, Christine S. Davis, & Robert F. Potter (Eds.), *The International Encyclopedia of Communication Research Methods*. Wiley-Blackwell. doi.org/10.1002/9781118901731.iecrm0100
- Read, Glenna L. (2020). Processing ambiguous social identity: Disclosure of identity and phenotypic prototypicality affect processing and evaluation of persuasive messages. *Journal of Communication*, 70, 693–720. doi.org/10.1093/jov/jqaa024
- Read, Glenna L., Holiday, Steven J., Hayes, Jameson L., & Britt, Brian C. (2024). Biometric tools in a computational advertising context: An overview of use and application. Special issue: Computational advertising research methodology. *Journal of Advertising*, 53(5), 754–770. doi.org/10.1080/00913367.2024.2399657
- Read, Glenna L. & Innis, Isaiah (2018). Electroencephalography (EEG). In Jörg Matthes, Christine S. Davis, & Robert F. Potter (Eds.), *The International Encyclopedia of Communication Research Methods*. Wiley-Blackwell
- Reeves, Byron, & Nass, Clifford I. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Center for the Study of Language and Information; Cambridge University Press.
- Simon, Herbert A. (1956). Rational choice and the structure of the environment. *Psychological Review*, 63(2), 129–138. doi.org/10.1037/h0042769
- Stanton, Steven J., Sinnott-Armstrong, Walter, & Huettel, Scott A. (2017). Neuromarketing: Ethical implications of its use and potential misuse. *Journal of Business Ethics*, 144, 799–811. doi.org/10.1007/s10551-016-3059-0
- Stern, Robert M., Ray, William J., & Quigley, Karen. S. (2001). *Psychophysiological recording* (2nd ed.). Oxford University Press.
- Strack, Fritz, Martin, Leonard L., & Stepper, Sabine (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology*, 54(5), 768–777. doi.org/10.1037//0022-3514.54.5.768
- Thorson, Esther, & Lang, Annie (1992). Effects of television videographics and lecture familiarity on adult cardiac orienting responses and memory. *Communication Research*, 19, 346–369. doi.org/10.1177/009365092019003003
- Tournas, Lucille N., & Johnson, Walter G. (2024). Algorithmic regulation: A compatible framework for AI and DTC neurotechnologies. In Marcello Ienca & Georg Starke (Eds.), *Developments in Neuroethics and Bioethics: Brains and Machines: Toward a Unified Ethics of AI and Neuroscience*, (Vol. 7), (pp. 143–159). Academic Press. doi.org/10.1016/bs.dnb.2024.02.008
- Wang, Zheng, & Lang, Annie (2012). Reconceptualizing excitation transfer as motivational activation changes and a test of the television program context effects. *Media Psychology*, 15(1), 68–92. doi.org/10.1080/15213269.2011.649604
- Wise, Kevin (2017). Electrocardiography (ECG). In Jörg Matthes, Christine S. Davis, & Robert F. Potter (Eds.), *The International Encyclopedia of Communication Research Methods*. Wiley-Blackwell.

