BIOMETRIC MEASURES FOR INTERACTIVE ADVERTISING RESEARCH

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ABSTRACT: Modern marketers seek new research paradigms to explore preconscious, nonverbal stages of consumer behavior, often turning to brain science because some mental processes, particularly those underlying conscious awareness, may be better understood by analyzing neurophysiological reactions. A new discipline, consumer neuroscience, thus examines the brain and its functioning in a marketing context. This article demonstrates how consumer neuroscience can contribute to existing marketing knowledge, with a focus on two methods: electroencephalography (EEG) and eye-tracking. In interactive environments, it is ideal to administer brain wave analyses in parallel with observations of eye movements. Such an integration can enrich understanding of what emotional reactions consumers experience when they see an advertisement. This study identifies a causal relationship between marketing communication and emotions on an analytical level, such that it reveals which emotional reaction is triggered by each ad element. In other words, it captures what people feel when they look at something. The EEG-eye-tracking integrative approach offers various opportunities to interactive advertising researchers.

Keywords: consumer neuroscience, brain waves, eye movements, high-technology in advertising research, visual attention, emotions, unconsciousnes

Neuroscientific Contributions to Marketing Research

Modern psychology reveals that some decisions, including economic ones, are made intuitively, automatically, and without any conscious control or effort (Bargh 1997; Bornstein and Pittman 1992; Dijksterhuijs 2004; Dixon 1971, 1981; Greenwald and Banaji 1995; Hassin et al. 2005, Jarymowicz 2001; Kihlstrom 1999; Murphy and Zajonc 1993; Ohme 2003, 2007, 2009; Uleman and Bargh 1989; Wilson 2002; Zajonc 1968, 1980, 1998). Conscious decisions in turn appear frequently based on emotional rather than rational cues (Bechara, Damasio, and Damasio 2000; Damasio 1999; Raghunathan and Tuan Pham 1999; Sayegh, Anthony, and Perrewé 2004) or triggered by subconscious stimulation (Murphy and Zajonc 1993; Ohme 2001, 2003, 2007, 2009; Zajonc 1968). People are not as rational as previously thought; for supporting this notion with empirical evidence, Daniel Kahneman even was awarded a Noble Prize in economics in 2002 (Kahneman 2003; see also Kahneman, Slovic, and Tversky 1982; Kahneman and Tversky 1973, 1979).

A large portion of human motivations thus lie below the level of consciousness. Extensive scientific research indicates that the "conscious window" fully opens up in the approximately 300 ms after a stimuli appears (Libet 2004), so events registered by the brain below this threshold likely cannot be reported verbally, even though they significantly influence the way people function (Kenning, Plassmann, and Ahlert 2007; Ohme 2007, 2009; Ohme et al. 2009). Emotions that people experience cannot be measured adequately by self-reported verbal indicators, because of their complexity and non-propositional structure (Davidson 2004; Zajonc 1980). Instead, self-reported verbal measures likely reflect socially acceptable answers or uncontemplated feedback (Nighswonger and Martin 1981).

In light of such discoveries, marketing researchers have grown increasingly skeptical of the use of verbal, conscious measures to test marketing communication, noting their limitations in providing an effective measure of internal reactions to external stimuli. Some authors thus claim that traditional techniques cannot discover what really leads a consumer toward certain behaviors (Zaltman 2003; Zurawicki and Braidot 2005). Marketers in turn have sought new research paradigms to explore preconscious, nonverbal stages of information processing. In line with a general trend in social sciences, consumer scientists have turned toward brain science. As Kenning, Plassmann, and Ahlert (2007) note, conscious emotional information processing and perception have been studied extensively in consumer research, even though we know little about how the human brain processes marketing stimuli.

Compelling evidence indicates that some mental processes, particularly those beyond conscious awareness, could be better understood by analyzing neurophysiological reactions, which

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demands the use of different neuroscientific approaches (Bechara, Damasio, and Damasio 2000; Damasio 1994; Ohme 2003; Kenning Plassmann, and Ahlert 2007; Posner 2004; Smith and Gevins 2000). In the neuroscience context, a new discipline also has recently emerged that examines the brain and its functioning and increases understanding of cognitive processes. Neuroscience thus offers new, high-tech methodologies that increasingly are used by cognitive neuroscientists, neurologists, psychophysiologists, and neuromarketers. These "early adopters" seem to realize that applying neuroscientific knowledge may help reveal the interplay of attention and emotions-constructs of great importance to the world of advertising communication. They also have come into possession of new tools that move beyond verbal declarations by respondents to investigate thoughts and emotions that may not be entirely consciously accessible or blind to subtle, peripheral, even if highly effective messages (Ohme et al. 2009). This article details two such neuroscientific methods: electroencephalography and eye-tracking. We thus demonstrate how neuroscience can contribute to existing marketing knowledge, as well as the new insights it may provide.

Selected Neurophysiological Methods for Marketing Research

Electroencephalography

Brainwaves have been observable since the mid-seventeenth century, beginning with the discovery that humans were controlled by electric impulses. A few more memorable events had to follow-such as Galvani's observation of a dead frog's leg moving-before the first electroencephalograph was constructed in the early twentieth century. This device measures the frequency of electric current in the brain using electrodes attached to the subject's head. The frequencies represent brainwaves according to their differing lengths.

It has been well established that patterns of brain activity are closely correlated with behavior and cognition (Alwitt 1985). Nunez and Srinivasan (2006) posit that electroencephalography (EEG) thus offers a "window into the mind," because it registers variations in brainwaves produced by the cortex. The first regular EEG studies started to appear during the 1980s. In a study of advertising content using EEG, Alwitt concluded that "the results of this analysis are an encouraging first look at the relationship between ongoing events and EEG-recorded brain reactions. The topic certainly warrants future research" (Alwitt 1985, p. 216). Thus EEG research in advertising has provided empirical evidence that certain aspects of consumer cognition and emotional response to advertising messages (even below conscious awareness) can be monitored successfully in real time and analyzed. However, Olson and Ray (1985) argue that EEG responses to advertising only provide useful information if they test specific hypotheses about the processes used by viewers. Thus EEG has not been considered as a general evaluative measure of advertising effectiveness.

The difference between early studies and the current research stems from the ease with which information can be obtained and analyzed. Modern computers are much more advanced, and we have considerably more sophisticated statistical programs, which use high-level technical computing languages and interactive environments for data visualization, analysis, and numeric computation. New technical possibilities contribute to both basic and applied EEG research. More recently EEG has helped assess marketing stimuli such as media involvement (Swartz 1998), the processing of television commercials (Rothschild et al. 1986), and the prediction of memory about components of televised commercials (Rothschild and Hyun 1990). Nearly a century after its first public demonstration, EEG has become a very popular method used by cognitive neuroscientists, neurologists, psychophysiologists, and neuromarketers as a noninvasive, relatively inexpensive method to measure brain activity. However, EEG has limited anatomical specificity and can only gather information from the cortex, though it offers very high temporal resolution. Other techniques (e.g., functional magnetic resonance imaging) suffer time resolutions of a few seconds, whereas EEG offers a submillisecond resolution (Huettel, Song, and McCarthy 2004). Therefore, researchers can detect changes in brain activity precisely, connected to rapidly changing stimuli.

Facial electromyography

Another psychophysiological technique used in market research is facial electromyography (EMG), which evaluates the physiological properties of facial muscles. The three muscles studied most extensively are the corrugator supercili, zygomaticus major, and orbicularis occuli. This method offers a powerful instrument to test voluntary (zygomaticus) and involuntary (corrugator and orbicularis) facial muscle movements, which may reflect the conscious and subconscious expression of emotions (Dimberg, Thunberg, and Elmehed 2000; Cacioppo et al. 1986; Cacioppo, Tassinary, and Berntson 2000; Larsen, Norris, and Cacioppo 2003; Ohme, Matukin, and Osiecki 2008). Facial EMG can study both emotional expressions and social communication. Some researchers also have managed to adapt EMG to track consumer reactions to advertising. For example, Bolls, Lang, and Potter (2001) show that zygomaticus muscle activity is stronger during radio advertisements with a positive emotional tone, whereas corrugator muscle activity is greater during ads with a negative emotional tone. Hazlett and Hazlett (1999) compare emotional reactions to television advertisements measured with facial EMG versus self-reported scales and find that EMG offers a more sensitive indicator of emotional reactions, such that facial EMG responses relate closely to emotion-congruent events during ads. They also find that compared with self-reports, facial EMG measures relate more to brand recall measures administered five days later. Thus, they conclude, "EMG measures can reflect a qualitative richness and complexity of the viewer's emotional response that self-report cannot and at the same time offer precise and continuous qualitative data" (Hazlett and Hazlett 1999, p. 19).

Skin conductance

A widely described and well-known measure of psychophysiological reactions is the measurement of skin conductance (SC). This method is based on the analysis of subtle changes in galvanic skin responses when the autonomic nervous system (ANS) is activated. Because an increase in the activation of the ANS is an indicator of arousal, SC can be used as a measure of such arousal (Ravaja 2004). In advertising research, measurement of SC is scarce, though some researchers, while testing other emotion measures, have used SC as a validation tool (Aaker, Stayman, and Hagerty 1986; Bolls et al. 2001). Citing interviews with market researchers who have applied SC and practitioner case studies, LaBarbera and Tucciarone (1995) conclude that SC predicts market performance better than self-reports, though they also formulate important guidelines for equipment and statistical formulas that should be adopted in SC research designs. Moreover, LaBarbera and Tucciarone argue that many previous SC studies in advertising (mostly conducted during the 1960s) failed to identify any effects because they lacked sufficiently sensitive equipment or accurate statistical protocols, which prevented them from separating "noise" from true arousal response. Individual variation also is apparent in SC. Today, technological advancements and complex statistical programs help overcome such difficulties, though a major limitation of SC remains: It cannot determine the direction or valence of an emotional reaction but merely measures the degree of arousal. Thus, both very pleasurable and very repellant advertising stimuli can evoke large SC responses (Hopkins and Fletcher 1994).

USING THE FRONTAL ASYMMETRY PARADIGM TO ASSESS EMOTIONS IN ADVERTISING

Theoretical Background

By measuring electrical brain activity in the frontal and prefrontal regions, we can infer the level of emotions generated by each second of any presented stimuli. The so-called frontal asymmetry paradigm aims to explore emotional reactions connected with approach-avoidance tendencies (Davidson et al. 1979, 1990). A large body of research on the relation between emotion and motivation has postulated the existence of two overarching motivational systems that organize human behavior. One system involves behavior prompted by a possible desirable outcome (approach tendencies); the other involves behavior prompted by a possible aversive outcome (avoidance tendencies) (Avila 2001; Carver and White 1994; Lang, Bradley, and Cuthbert 1990). In 1979, Davidson and colleagues proposed a model regarding frontal EEG asymmetry during emotional states, in which they posited that the left prefrontal cortex (PFC) is involved with the system that facilitates approach behavior, whereas the right PFC is involved with the system that facilitates withdrawal behavior from aversive stimuli. Using EEG measures to index the ongoing frontal brain activity during the processing of different affects, these researchers find substantial empirical support for this model in adults and infants (see Davidson 1993; Davidson and Rickman 1999; Fox 1991). In the model, greater relative left frontal EEG activity is associated with the processing of positive affect (e.g., viewing film clips containing pleasant scenes), but greater relative right frontal EEG activity implies processing of negative affects (e.g., viewing film clips containing unpleasant scenes) (Jones and Fox 1992). Various independent studies have examined the relationship between emotion or emotion-related constructs and asymmetry in EEG activity in the frontal cortex (see Coan and Allen 2003). We refer to approach-related tendencies (or left-hemispheric dominance) as "positive emotional reactions" and withdrawal-related tendencies (or right-hemisphere dominance) as "negative emotional reactions."[1]

Brain asymmetry, whether frontal or otherwise, is still a conceptual construct with obvious limitations and some competing explanations, not quite a versatile tool to understand the brain's reactions to any stimuli through cognitive and affective processes. Yet the quantity and quality of empirical evidence in support of the frontal asymmetry hypothesis is compelling.

The Frontal Asymmetry Paradigm in Televised Advertising Tests

In the past six years, we have conducted series of studies to demonstrate how psychophysiological measures might be applied to test marketing communication and the effectiveness of creative idea execution. In one study (Ohme et al. 2010b), we have identified frontal cortex activation in reaction to television advertisements, using a comparison of three consecutive creative executions of Sony Bravia ads ("Balls," "Paints," and "Play-Doh"). We looked for left-hemispheric dominance, which would indicate positive reactions of the respondents to the stimuli, but dominant reactions occurred only in response to one of the tested ads, "Balls." Target group respondents reacted to the emotional part of the ad, as well as to its informational section (i.e., product benefits, products, and brand exposure scenes). No similar pattern appeared for the other two ads, though they contained similar features.

In another study (Ohme, Matukin and Szczurko 2010), we considered how brainwave analysis of emotional reactions to the "Balls" ad might help identify a seemingly irrelevant and irrational ad element-the frog scene-that could have instrumental as well as artistic power. That is, in the "Balls" ad, respondents indicated positive reactions to the informational part, which was preceded by the frog scene. We confirmed that affective iconic priming occurred on a neurophysiological level and can be traced with EEG measures and the frontal asymmetry paradigm. This study thus yielded another empirical example of how a small, peripheral element can be a key moment in advertising persuasion.

These findings and conclusions are consistent with another study in which we tested a television advertisement for a skin care product (Ohme et al. 2009). Traditional paper-and-pencil pretests of two versions of the ad revealed that though they were nearly identical, each generated significantly different impacts, according to both cognitive measures (benefits and key benefit recall) and behavioral measures (shelf test). Yet the only difference was a single scene that contained a gesture made by a female model; this single gesture appeared to enhance the effectiveness of the ad. By using EEG and EMG and monitoring SC, we could register significant differences in neurophysiological reactions to an altered scene, even though the respondents did not consciously see the difference.

MEASURES OF VISUAL ATTENTION USING EYE-TRACKING

History and Theoretical Background

Studies of eye movement have a long history. In the nineteenth century, Emile Javal (reported by Huey 1908) discovered that eyes do not move continuously along text, as previously assumed, but instead make short, rapid movements, intermingled with short stops. These discoveries were confirmed with eye-tracking technology in subsequent eye-tracking studies (for a review, see Rayner 1978, 1998). The short rapid movements and short stops are now known as saccades (i.e., continuous, rapid movement of eye gazes between fixations with a velocity of 500 degrees or more) and fixations (i.e., a relatively motionless gaze that lasts 200-300 ms, in which visual attention is aimed at a specific area of a visual display; Rayner 1998), and they remain the most widely used terms to describe eye movements.

Early technologies for tracking the location of eye fixations were quite invasive, involving direct mechanical contact with the cornea. The first nonintrusive eye tracker, using beams of light reflected on the eye and then recorded on film, was used by Guy Thomas Buswell (1920) to study reading and picture viewing; Hartridge and Thompson (1948) then invented the first head-mounted eye tracker. A wide range of eye-trackers now exist, though they mainly represent three categories: invasive, such as a special contact lens with embedded sensors (used in medicine diagnosis and studies of the physiology of eye movements); EOG electrodes placed near the eyes to register variations in the electric field (sensitive to even miniature saccades and capable of working without a light and with eyes closed, as widely used in studies on sleep); and optical eye-trackers, which reflect light, typically infrared, in the eye and measure it with a video camera or some specially designed optical sensor. The latter category are neither invasive nor expensive and thus are used most frequently. Moreover, they can support quantitative, not just qualitative, studies. Therefore, we focus specifically on optical eye-tracking studies.

These studies, including those in marketing, have flourished not only due to technological developments but also because of the great advances in psychological theories that link eye-tracking data with cognitive processes (e.g., Jacob and Karn 2003). In their strong eye-mind hypothesis, Just and Carpenter (1976a, 1976b) claim that no appreciable lag occurs between what a person fixates on and what he or she processes, so when a person looks at a word or object, he or she also cognitively processes that word or object for exactly as long as the recorded fixation. Thus gaze direction can be linked to the focus of attention, which provides a mechanism to filter information received by an organism (Deutsch and Deutsch 1963; Posner and Peterson 1990; Treisman 1964). This hypothesis has been questioned, though modern research has proven systematically that shifts of attention without eye movement is possible (Posner 1980), and as soon as attention moves to a new position, the eyes follow if they can (Hoffmann 1998). The questions that remain then are, What conditions or features evoke attentional shifts to specific locations, and what is the nature of the emotional and motivational processes behind visual attention?

Selected Research Areas

People usually focus their eyes on objects, which may provide important information (Yarbus 1967). Moving attention depends on task requirements (Folk, Remington, and Johnston 1992; Hayhoe and Ballard 2005), though some elements have a higher likelihood of capturing attention, especially elements with greater biological meaning, such as movements (Hillstrom and Yantis 1994), distinctive or salient objects (Theeuwes 1994; Yarbus 1967), emotional stimuli (Calvo and Lang 2004), and people's faces (Bruce et al. 1992; Young 1998). Human faces are processed and recognized faster and more accurately than any other visual stimuli (Bruce and Young 1986), and evidence suggests that face processing is enhanced if the face has emotional meaning (Öhman, Lundqvist, and Esteves 2001; Ohme 2003, 2007).

Emotional material captures attention much faster and holds it longer than neutral material (Calvo and Lang 2004; Nummenmaa, Hyönä, and Calvo 2006). However, there is no full agreement about the impact of the emotional valence of the stimuli on visual attention. Some researchers hypothesize that only negative stimuli with high evolutionary meaning can facilitate cognitive processing, because they are noticed faster even in a highly distracting environment (Calvo and Lang 2004; Öhman, Flykt, and Esteves 2001). However most evidence suggests that both negative and positive stimuli can capture and hold attention (Kolańczyk 2004; Nummenmaa, Hyönä, and Calvo 2006; for a review, see Vuilleumier 2005).

The eye-tracker technique is a well-validated tool to identify the flow of visual attention and its strongest attractors (Chanon et al. 2007; Hollingworth and Henderson 2002). Recordings from eye-tracker studies can reveal the hierarchy of perceptions of stimulus material (i.e., which elements are perceived earlier, which later, and which remain peripheral or consciously unnoticed) and the contact time (i.e., how long each element is attended to). With its ease of application, eye tracking has been used in various research areas, such as when cognitive psychologists gain data about the timing of ocular and attentional movements (Chanon et al. 2007; Posner 1980), synchronization and desynchronization in binocular eye movements (Altmann and Kamide 2009), and cognitive speed and working memory (Mitchell, Macrae, and Glichrist 2002). It provides valuable information on visual perception, such as the identification and categorization of visual objects (Hollingworth and Henderson 2002) or the ability to assess distances to and between objects (Currie et al. 2000). Cognitive linguistics studies use eye tracking to gain an understanding of the processes of reading and language comprehension, as well as the clarity of a written message (Gonzalez-Marquez et al. 2005). Eye trackers are also used in human-computer interfaces to aid disabled or paralyzed people (Abbot 2006). In psychiatry, eye tracking has advanced research in autism (Dapretto et al. 2006) and schizophrenia (Lezenweger and Gold 2000). Finally, eye tracking found its way to commercial applications, including web usability, advertising, package and product design, automotive engineering, movies, gaming, and shelf and shop testing (Brasel and Gips 2008).

Eye Tracking in Market Research

Market research first used eye tracking for qualitative analyses, including single-person data analyses and in-store research, in which setting it could analyze what consumers really notice while shopping. In usability research, especially for websites, eye trackers determine the clearance of the website/advertisement/user interface construction and visibility of particular elements. In recent years, quantitative analyses also have investigated areas of interest, such as preselected places of foveal vision concentration. Such analyses are particularly effective to test packaging designs to determine if important elements such as the brand or product name are visible (Gofman et al. 2009).

INTEGRATION WITH EEG: WHAT DO PEOPLE FEEL WHEN THEY LOOK?

Shortcomings in Standalone Applications

Advertising practitioners often implicitly assume that more visual attention means a positive reaction to the attended element, based on a common intuition that greater attention reflects greater interest, and greater interest equals a positive reaction or liking. This heuristic is strongly supported in everyday language; when we say "I am interested," we usually mean, "I like it." However in tests in commercial settings, we have frequently found that the most visually attended elements do not trigger positive reactions (as indicated by the frontal asymmetry paradigm). Instead, such elements can cause negative or neutral reactions (e.g., when a product and the visual do not match). We therefore posit that attentional focus does not necessarily lead to positive emotional reactions.

Standalone eye-tracking measures cannot assign emotional valence to attended stimuli though, nor can they offer definitive information about consumers' emotional experience when they view an advertisement. Gazes, scan paths, and heat maps can provide valuable information about visual attention, but they still are not able to reveal affective aspects of the stimuli. Some theories associate pupil dilation with emotional engagement, though this measure is questionable, because many factors can influence pupil dilation that have nothing to do with the emotional engagement, such as changes in illumination (Beatty and Lucero-Wagoner 2000), cognitive workload (Kahneman and Tversky 1973; Kramer 1991), and participants' gaze angle (Kleinke 1986). Thus pupil dilation alone cannot be considered an indicator of affective states.

To determine what emotional valence is associated with visually attended stimuli, researchers have two options: verbal declarations of respondents or analyses of nonverbal brain reactions. Declarative measures are much simpler and easier to gather but may be biased by cognitive distortions typical of post factum responses (e.g., primacy or recency) and rarely correspond to the time flow of emotional reactions (Matukin and Ohme, in press). Brain imaging measures are not susceptible to such cognitive distortions because they do not require verbal reactions from respondents (Ohme et al. 2009).

The EEG measures of emotions can precisely detect changes in brain activity generated by marketing communications. The most widely used methods aggregate moment-to-moment measures into a single mean value or use event-related potentials (Ma et al. 2008; Zhang et al. 2003). Yet standalone EEG analyses also lose information about temporal dynamics and the flow of emotional reactions. Thus they cannot reveal which objects evoke the observed emotional reactions-the brand, a headline, or visuals?

To find the answer, we suggest administering EEG in parallel with observations of eye movements. We thus need to synchronize recordings from both independent sources, which offers an opportunity to determine the foundations of cognitive and emotional reactions to incoming visual stimuli and infer both analytic and holistic meanings of marketing messages. In other words, this integration should be able to capture what we feel when we look at something. We present a brief example of exploratory research that integrates EEG with eye-tracking recordings to contribute to a better understanding of how consumers process visual stimulation. We thus highlight the great opportunity of such integration for a greater comprehension of the "mental mechanics" in response to interactive advertising.

The Integrated Approach

In previous studies, we have successfully integrated neurophysiological measures (Ohme, Matukin, and Szczurko 2010; Ohme et al. 2009). We also have attempted to show how combining EEG with eye tracking can enrich marketing research on static advertising (Ohme, Matukin, and Pacula-Lesniak 2011) and perhaps interactive advertising. We introduce a new exploratory method, based on the frontal asymmetry paradigm, designed to understand what respondents feel when they look at the visual stimulation of two versions of a DVD cover: an original version and one that also featured logos for the awards the movie had won.

Our eye-tracking measures showed that for both covers (with and without award information), respondents engaged in visual exploration and attended to all the main elements. However, the cover with the awards information seems to harm legibility, which is not surprising, in that it contains an additional element that must be assessed. Cognitive processing of that additional element consumed some of the respondents' attentional resources, whereas they had more time and mental energy to spend on the original cover. Based solely on the eye-tracking findings, we would have recommended the cover without the awards information as a more effective version.

With the EEG measurements, we also estimated emotional reactions to the two covers. The additional information about awards apparently exerted no influence on perceptions of the cover; thus we confirm that placing awards logos on a DVD cover is not an optimal communication tactic. However, had we relied solely on the EEG findings, we could not have recommended either version, because both covers prompted equal perceptions.

Finally, we integrated both findings to identify exactly which emotions were triggered by the particular elements of each cover. For the participants who viewed the cover with the awards information, we find an emotional preference for information about awards. Therefore, if we made our recommendation on the basis of integrated EEG and eye-tracking data, we would suggest the DVD cover with the award information as more effective.

Thus the observations from the integrated approach differ significantly from those we obtained from the separate analyses. We believe that the integrated approach provides a wider perspective, in that we can locate the source of a reaction precisely (based on eye tracking) and also determine the emotional valence of the reaction (based on EEG). Moreover, the integrated approach offers useful and practical recommendations for advertisers (e.g., include award logos but place them using better spatial management).

IMPLICATIONS FOR INTERACTIVE ADVERTISING

New Opportunities for Research

The integrated approach can test a variety of marketing stimuli, beyond static stimuli such as print ads or DVD covers (Ohme, Matukin, and Pacula-Lesniak 2011). For example, it could test advertisements in interactive media such as online advertisements, website architectures, games, or in-game advertisements. When EEG measures are synchronized with eye-tracking measures, they can estimate consumer reactions to different forms of advertising on websites, including links, static banners, dynamic banners, or pop-ups. This tool offers precise estimations and can help improve the efficiency of website messages by revealing their best spatial position, the best timing, and the best creative executions. Advertisers will benefit from such analyses in almost all aspects of online advertising, because they can optimize their messages to ensure emotional reactions, legibility, user-friendliness, and behavioral efficiency. Moreover, the precise identification of the source and effect (i.e., visual element and corresponding emotional reactions) offers specific instructions about how to improve a particular communication element.

The synchronization of EEG and eye tracking also enables an estimation of the unconscious reactions to a website's architecture. These estimated reactions have great value for determining user-friendliness, content, and design, as well as to improve the communication potential of the site by revealing the best main visual, appropriate spatial positions of strategic elements (e.g., logo, headline, pricing, contact information), and strong and weak aspects of a composition. Marketers can take into account not only the overall impression but moment-to-moment attentional and emotional reactions during an interaction-at the beginning, in the middle, and near the end of the interaction.

Another likely usage involves the gaming industry. Game designers can measure both the visibility and emotional reactions to in-game ads and reactions to the game itself. This application appears particularly important because a good integration of game content with in-game advertisements increases both interest in the product and purchase intentions (Chang et al. 2010). It can also make games more realistic and exciting (Wegert 2005). There are many crucial issues for in-game advertising: Do reactions to the ads depend on the player's eventual outcome? Is there any influence of game content on implanted commercials? Are there any differences between the conscious self-reports and unconscious neurophysiological reactions to such commercial messages?

Challenges

To introduce high-tech methods to study interactive advertisement demands that we address some issues that continue to make the application of the integrated approach difficult. First, sample size is critical. Even in analyses of static, non-interactive pictures, we observe significant decrements in the number of valid observations, for several reasons (Ohme, Matukin, and Pacula-Lesniak 2011). In an interactive advertisement setting, this loss could be even greater, because the key influence on information loss is the demand of statistical computations, which require respondents to fit a specific condition. If respondents can move freely across the layouts, they are increasingly likely never to notice some important elements, so the valid sample shrinks. Therefore, we recommend at least 60 respondents per cell.

Second, we need to address the potential movements of respondents during test sessions. In an interactive condition, respondents usually use some devices, such as a mouse, keyboard, joystick, or console. These movements can cause recording errors (e.g., sensors read artifacts, changes alter the activation of the motor cortex). Each respondent also moves according to his or her own individual way and timing, which introduces an additional source of unsystematic error. In an interactive condition, each output is unique, so we would need to prepare them individually, which would make their analyses complex and time consuming. Research being conducted into intelligent software that can recognize a respondent, time, layout, and area of interest at the same moment and synchronize the data with respondents' reactions, as recorded by the biometric sensors, may help address this concern.

CONCLUDING REMARKS

The integration of EEG and eye-tracking measures can enrich our understanding of what emotional reactions consumers experience when they see an ad. The integrated approach can identify a causal relationship between a marketing communication and emotions, and do so on an analytical level. We thus can identify which emotional reaction is triggered by each ad element. This ability is new to contemporary marketing research, and we believe it offers immediate advantages to marketers: They can receive practical recommendations on how to design the visual composition of their print and outdoor ads, packages, brochures, and digital media, and they can create user-friendly web pages or other interactive communication forms. Modern marketers thus may learn how to connect with consumers, according to not only their verbally reported conscious feelings but also their unconscious emotions, as identified by high-technological instruments.

The most fruitful scientific progress often occurs at the intersection of diverse scientific fields-as evidenced by the interaction of psychology, neuroanatomy, neurobiology, psychophysiology, and cognitive and computer sciences under the umbrella of neuroscience. The time has come for marketing researchers to venture out from their silos and look to other disciplines for ideas for improvements. Zaltman (2003, p. xii, emphasis in original) hints at this notion by stating that "we must explore many disciplines, since the most promising knowledge frontiers typically exist at the boundaries *between* fields rather than at the field's respective centers." We believe that the frequency of biometric applications to marketing research will increase; we finally possess technological and computational capabilities sufficient to perform most sophisticated experiments. However, as Kenning, Plassmann, and Ahlert (2007) warn, we must keep in mind that biometric research methods remain in their infancy, and further research is necessary to facilitate their confident application.

FOOTNOTES

[1]Some negative emotional states may evoke approach tendencies, such as anger (Harmon-Jones 2003), yet because mainstream marketing communication consists mostly of positive stimuli, it is unlikely that it would attempt to put consumers in an angry mode.

REFERENCES

Aaker, David A., Douglas M. Stayman and Michael R. Hagerty (1986), "Warmth in Advertising: Measurement, Impact and Sequence Effects," *Journal of Consumer Research*, 12 (March), 365-81.

Abbot, Alison (2006), "Neuroprosthetics: In Search of the Sixth Sense," *Nature,* 442, 125-27.

Altmann, Garry T. M. and Yuki Hamide (2009), "Discourse-Mediation of the Mapping Between Language and the Visual World: Eye Movements and Mental Representation," *Cognition,* 111 (1), 55-71.

Alwitt, Linda F. (1985), "EEG Activity Reflects the Content of Commercials," in *Psychological Processes and Advertising Effects: Theory, Research, and Applications*, Linda F. Alwitt and A.A. Mitchell, eds. Hillsdale, NJ: Lawrence Erlbaum, 209-19.

Avila, C. (2001), "Distinguishing BIS-Mediated and BAS-Mediated Disinhibition Mechanisms: A Comparison of Disinhibition Models of Gray (1981, 1987) and of Patterson and Newman (1993)," *Journal of Personality and Social Psychology,* 80, 311-24.

Bargh, John A. (1997), "The Automaticity of Everyday Life," in *The Automaticity of Everyday Life: Advances in Social Cognition,* Vol. 10, R. S. Wyer, Jr., ed. Mahwah, NJ: Erlbaum, 1-61.

Beatty, Jackson and Brennis Lucero-Wagoner (2000), "The Pupillary System," in *Handbook of Psychophysiology*, 2d ed., John T. Cacioppo, G. Berntson, and L.G. Tassinary, eds. Cambridge: Cambridge University Press, 142-62.

Bechara, Antoine, Hanna Damasio, and Antonio R. Damasio (2000), "Emotion, Decision Making and the Orbitofrontal Cortex," *Cerebral Cortex,* 10 (3), 295-307.

Bolls, Paul D., Annie Lang, and Robert F. Potter (2001), "The Effect of Message Valence and Listener Arousal on Attention, Memory, and Facial Muscular Responses to Radio Advertisements,"*Communication Research*, 28 (5), 627-651.

Bornstein, Robert F. and Shane S. Pittman (1992), *Perception Without Awareness.* New York: The Guilford Press.

Brasel, Adam and James Gips (2008), "Breaking Through Fast-Forwarding: Brand Information and Visual Attention," *Journal of Marketing*, 72 (6), 31-48.

Bruce, Vicki, Alan Cowey, W. Ellis, and Dawid I. Perrett (1992), *Processing the Facial Image*. Oxford: Clarendon Press.

Bruce, Vicki and Andrew Young (1986), "Understanding Face Recognition," *British Journal of Psychology,* 77, 305-27.

Buswell, Guy T. (1920), *An Experimental Study of the Eye-Voice Span in Reading. Reading, Psychology of Eye Movements.* Chicago: University of Chicago.

Cacioppo, John T., Richard E. Petty, Mary E. Losch, and Hai S. Kim (1986), "Electromyographic Activity over Facial Muscle Regions Can Differentiate the Valence and Intensity of Affective Reactions,"*Journal of Personality and Social Psychology,* 50 (2), 260-68.

Cacioppo, John T., Tassinary, Louis G., and Gary C. Berntson, (2000), *Handbook of Psychophysiology*. Second Edition, NY: Cambridge University Press.

Calvo, Manuel G. and Peter J. Lang (2004), "Gaze Patterns When Looking at Emotional Pictures: Motivationally Biased Attention," *Motivation and Emotion,* 28, 221-43.

Carver, Charles S. and T.L. White (1994), "Behavioral Inhibition, Behavioral Activation, and Affective Responses to Impending Reward and Punishment: The BIS/BAS Scales," *Journal of Personality and Social Psychology*, 67 (2), 319-33.

Chang, Yaping, Juan Yan, Jinlong Zhang, and Jin Luo (2010), "Online In-Game Advertising Effect: Examining the Influence of a Match Between Games and Advertising," *Journal of Interactive Advertising,* 11 (1), 63-73.

Chanon, M. Johnes, J. Young, Robert Gray, Charles Spence, and Hong Z. Tan (2007), "An Eyetracker Study of the Haptic Cuing of Visual Attention," Second Joint Euro Haptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems.

Coan, James A. and John J.B. Allen (2003), "Frontal EEG Asymmetry and the Behavioral Activation and Inhibition Systems," *Psychophysiology,* 40, 106-14.

Currie, Christopher B., George W. McConkie, Laura A. Carlson-Radvansky, and David E. Irwin (2000), "The Role of the Saccade Target Object in the Perception of a Visually Stable World," *Perception & Psychophysics,* 62, 673-83.

Damasio, Antonio R. (1994), *Descartes' Error. Emotion, Reason, and the Human Brain*. New York: Putnam's Sons.

--- (1999), *The Feeling of What Happens: Body and Emotion in the Making of Consciousness.* New York: Harcourt-Brace.

Dapretto, Mirella, Mari S. Davies, Jennifer H. Pfeifer, Ashley A. Scott, Marian Sigman, Susan Y. Bookheimer, and Marco Iacoboni (2006), "Understanding Emotions in Others: Mirror Neuron Dysfunction in Children with Autism Spectrum Disorders," *Nature Neuroscience,* 9, 28-30.

Davidson, Richard J. (1993), "The Neuropsychology of Emotion and Affective Style," in *Handbook of Emotion*, M. Lewis and J.M. Haviland, eds. New York: Guilford Press, 143-54.

--- (2004), "What Does the Prefrontal Cortex ‘Do' in Affect: Perspectives on Frontal EEG Asymmetry Research," *Biological Psychology,* 67, 219-33.

---, Paul Ekman, C.D. Saron, J.A. Senulis, and W.V. Friesen (1990), "Approach-Withdrawal and Cerebral Asymmetry: Emotional Expression and Brain Physiology I," *Journal of Personality and Social Psychology*, 58, 330-41.

--- and Maureen Rickman (1999), "Behavioral Inhibition and the Emotional Circuitry of the Brain: Stability and Plasticity During the Early Childhood Years," in *Extreme Fear, Shyness, and Social Phobia: Origins, Biological Mechanisms, and Clinical Outcomes,* L.A. Schmidt and J. Schulkin, eds. New York: Oxford University Press, 67-87.

---, Gary E. Schwartz, Clifford Saron, John Bennett, and Daniel J. Goleman (1979), "Frontal Versus Parietal EEG Asymmetry During Positive and Negative Affect," *Psychophysiology,* 16, 202-203.

Deutsch J.A. and D. Deutsch (1963), "Attention: Some Theoretical Considerations," *Psychological Review,* 70, 80-90.

Dijksterhuijs, Ap. (2004), "Think Different: The Merits of Unconscious Thought in Preference Development and Decision Making," *Journal of Personality and Social Psychology,* 87 (5), 586-98.

Dimberg Ulf, Monica Thunberg, and Kurt Elmehed (2000), "Unconscious Facial Reactions to Emotional Facial Expressions," *Psychological Science,* 11 (1), 86-89.

Dixon, Norman F. (1971), *Subliminal Perception: The Nature of Controversy.* London: McGraw-Hill.

--- (1981), *Preconscious Processing.* New York: John Wiley & Sons.

Folk, Charles L., Roger Remington, and James. C. Johnson (1992), "Involuntary Covert Orienting Is Contingent on

Attentional Control Settings," *Journal of Experimental Psychology: Human Perception and Performance,* 18, 1030-44.

Fox, Nathan A. (1991), "If It's Not Left, It's Right: Electroencephalogram Asymmetry and the Development of Emotion," *American Psychologist*, 46, 863-72

Gofman, Alex, Howard Moskowitz, Johanna Fyrbjork, David Moskowitz, and Tonis Mets (2009), "Extending Rule Developing Experimentation to Perception of Food Packages with Eye Tracking," *Open Food Science Journal*, 3, 66-78.

Gonzalez-Marquez, Monica, Irene Mittelberg, S. Coulson, and M.J. Spivey (2005), *Empirical Methods in Cognitive Linguistics*. Amsterdam: John Benjamins.

Greenwald, Anthony G. and Mahzarin R. Banaji (1995), "Implicit Social Cognition: Attitudes, Self-Esteem, and Stereotypes," *Psychological Review,* 102, 4-27.

Harmon-Jones, Eddie (2003), "Anger and Behavioral Approach System," *Personality and Individual Differences,* 35, 995-1005.

Hartridge, H. and L. C. Thompson (1948), "Methods of Investigating Eye Movements," *British Journal of Ophthalmology,* 32, 581-91.

Hassin, Ran R., James. S. Uleman, and John A. Bargh (2005), *The New Unconscious.* New York: Oxford University Press.

Hayhoe, Mary and Dana Ballard (2005), "Eye Movements in Natural Behavior," *TRENDS in Cognitive Sciences,* 9 (4), 188-93.

Hazlett, Richard L. and Sasha Y. Hazlett (1999), "Emotional Response to Television Commercials: Facial EMG vs. Self Report," *Journal of Advertising Research,* 39, 7-23.

Hillstrom, Anne P. and Steven Yantis (1994),"Visual Motion and Attentional Capture," *Perception and Psychophysics,* 55, 399-411.

Hoffman, James E. (1998), "Visual Attention and Eye Movements," in *Attention*, H. Pashler, ed. Hove, UK: Psychology Press, 119-54.

Hollingworth, Andrew and John M. Henderson (2002), "Accurate Visual Memory for Previously Attended Objects in Natural Scenes," *Journal of Experimental Psychology: Human Perception and Performance,* 28 (1), 113-36.

Hopkins, R. and J. Fletcher (1994), "Electrodermal Measurement Particularly Effective for Forecasting Message Influence on sales Appeal," in *Measuring Psychological Responses to Media,* A. Lang, ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 113-32.

Huettel, Scott A., Allen W. Song, and Gregory McCarthy, (2004), *Functional Magnetic Resonance Imaging*. Boston, MA: Sinauer Associates.

Huey, Edmund B. (1908), *The Psychology and Pedagogy of Reading*. Cambridge, MA: MIT Press (reprinted 1968).

Jacob, Robert J.K. and K.S. Karn (2003), "Eye Tracking in Human-Computer Interaction and Usability Research: Ready to Deliver the Promises," in *The Mind's Eye: Cognitive and Applied Aspects of Eye Movement Research,* R. Radach, J. Hyona, and H. Deubel, eds. Boston, MA: North-Holland/Elsevier, 573-605.

Jarymowicz, Maria (2001), *Pomiędzy afektem i intelektem: poszukiwania empiryczne.* [*Between Affect and Intellect: Empirical Explorations*]. Warszawa: Wydawnictwo IP PAN.

Jones, Nancy A. and Nathan A. Fox (1992), "Electroencephalogram Asymmetry During Emotionally Evocative Films and its Relation to Positive and Negative Affectivity," *Brain and Cognition*, 20, 280-99.

Just, Marcel A. and Patricia A. Carpenter (1976a), "Eye Fixations and Cognitive Processes," *Cognitive Psychology,* 8, 441-80.

--- and --- (1976b), "The Role of Eye-Fixation Research in Cognitive Psychology," *Behavior Research Methods and Instrumentation,* 8, 139-43.

Kahneman, Daniel (2003), "Maps of Bounded Rationality: A Perspective on Intuitive Judgment and Choice," in *Les Prix Nobel 2002 [Nobel Prizes 2002]*. T. Frangsmyr, ed. Stockholm, Sweden: Almquist and Wiksell International.

---, Paul Slovic, and Amos Tversky (1982), *Judgment under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press.

--- and Amos Tversky (1973), "On the Psychology of Prediction," *Psychological Review,* 80, 237-51.

--- and --- (1979), "Prospect Theory: An Analysis of Decisions under Risk," *Econometrica*, 47, 313-27.

Kenning, Peter, Hilke Plassmann, and Dieter Ahlert (2007), "Applications of Functional Magnetic Resonance Imaging for Market Research," *Qualitative Market Research*, 10 (2), 135-52.

Kihlstrom, John F. (1999), "Conscious Versus Unconscious Cognition," in *The Nature of Cognition*. R. J. Sternberg, ed. Cambridge MA: MIT Press, 173-203.

Kleinke, Chris L. (1986), "Gaze and Eye Contact: A Research Review," *Psychological Bulletin* 100(1), 78-100.

Kolańczyk, Alina (2004), *Serce w rozumie. Afektywne podstawy orientacji w otoczeniu* [*The Heart in the Mind. Affective of Orientation in the Environment*]. Gdańsk: Gdańskie Wydawnictwo Psychologiczne.

Kramer, Arthur F. (1991), "Physiological Metrics of Mental Workload: A Review of Recent Progress," in *Multiple-Task Performance,* D.L. Damos, ed. London: Taylor & Francis.

LaBarbera, Priscilla A. and Joel D. Tucciarone (1995), "GSR Reconsidered: A Behavior-Based Approach to Evaluating and Improving the Sales Potency of Advertising," *Journal of Advertising Research,*35, 33-53.

Lang, Peter J., Margaret M. Bradley, and Bruce N. Cuthbert (1990), "Emotion, Attention, and the Startle Reflex," *Psychophysiological Review*, 97, 377-98.

Larsen, Jeff T., Cathrine J. Norris, and John T. Cacioppo (2003), "Effects of Positive and Negative Affect on Electromyographic Activity over Zygomaticus Major and Corrugator Supercilii,"*Psychophysiology,* 40, 776-85.

Lezenweger, Mark F. and J.M. Gold (2000), "Auditory Working Memory and Verbal Recall Memory in Schizotypy," *Schizophrenia Research*, 42 (2), 101-10.

Libet, Benjamin (2004), *Mind Time: The Temporal Factor in Consciousness. Perspectives in Cognitive Neuroscience.* Cambridge, MA: Harvard University Press.

Ma, Qingguo, Xiaoyi Wang, Liangchao Shu, and Shenyi Dai (2008), "P300 and Categorization in Brand Extension," *Neuroscience Letters*, 431, 57-61.

Matukin, Michał and Rafał Ohme (in press). "Badajmy przebieg reakcji emocjonalnej w czasie" ("Let's Test the Temporal Dynamic of the Emotional Reaction"), in *Dynamika emocji: Teoria i praktyka*(*Dynamics in Emotions: Science and Practice*), D. Doliński and W. Błaszczak, eds. Warsaw: Wydawnictwo Naukowe PWN.

Mitchell, Jason P., C. Neil Macrae, and Iain D. Gilchrist (2002), "Working Memory and the Suppression of Reflexive Saccades," *Journal of Cognitive Neuroscience*, 14 (1), 95-103.

Murphy, Sheila T. and Robert B. Zajonc (1993), "Affect, Cognition, and Awareness: Affective Priming with Suboptimal and Optimal Stimulus," *Journal of Personality and Social Psychology,* 64, 723-39.

Nighswonger, Nancy J. and Claude R. Martin Jr. (1981), "On Using Voice Analysis in Marketing Research," *Journal of Marketing Research*, 18, 350-55.

Nummenmaa, Lauri, Jukka Hyönä, and Manuel G. Calvo (2006), "Eye Movements Assessment of Selective Attentional Capture by Emotional Pictures," *Emotion,* 6 (2), 257-68.

Nunez, Paul L. and Ramesh Srinivasan (2006), "A Theoretical Basis for Standing and Traveling Brain Waves Measured with Human EEG with Implications for an Integrated Consciousness," *Clinical Neurophysiology*, 11, 2424-35.

Öhman, Arne, Anders Flykt, and Francisco Esteves (2001), "Emotion Drives Attention: Detecting the Snake in the Grass," *Journal of Experimental Psychology: General,* 130, 466-78.

---, Daniel Lundqvist, and Francisco Esteves (2001), "The Face in the Crowd Revisited: A Threat Advantage with Schematic Stimuli," *Journal of Personality and Social Psychology,* 80, 381-96

Ohme, Rafal (2001), "The Implicit Conditioning of Consumer Attitudes: Logo Substitution Effect," *Polish Psychological Bulletin,* 32 (1), 71-78.

--- (2003), *Podprogowe Informacje Mimiczne* (*Subliminal Facial Cues*). Warsaw: IP PAN and SWPS.

--- (2007), *Nieuswiadomiony Afekt* (*Subconscious Affect*). Sopot: GWP.

--- (2009), "The Subconscious as the Third Dimension in Advertising," *American Academy of Advertising Newsletter,* 5 (4), 1-5.

---, Michal Matukin, and K. Osiecki (2008), "How to Design, Conduct and Analyze Biometric Research Applying EEG, EMG, GSR and ET Methods," working paper, Human Mind and Brain Applied Research Center.

---, ---, and Beata Pacula-Lesniak (2011), "What Do We Feel When We Look? Explorative Consumer Research to Integrate Eye Movements and Brain Waves Reactions," working paper.

---, ---, and Tomasz Szczurko (2010), "Neurophysiology Uncovers Secrets of TV Commercials," *Der Markt-Journal für Marketing*, 49 (3-4), 133-42.

---, Dorota Reykowska, Dawid Wiener, and Anna Choromanska (2009), "Analysis of Neurophysiological Reactions to Advertising Stimuli via EEG and GSR Measures," *Journal of Neuroscience, Psychology, and Economics,* 2 (1), 21-31.

---, ---, ---, and --- (2010), "Application of Frontal EEG Asymmetry to Advertising Research," *Journal of Economy Psychology - Special Issue: Decisions and Neuroscience*, 13, 785-93.

Olson, Jerry C. and William J. Ray (1983), "Using Brain-Wave Measures to Assess Advertising Effects," *MSI Report* No. 83-108, Cambridge, MA: Marketing Science Institute.

Posner, Michael I. (1980), "Orienting of Attention," *Quarterly Journal of Experimental Psychology*, 32, 3-25.

--- (2004), *Cognitive Neuroscience of Attention.* New York: Guilford

--- and S.E. Petersen (1990), "The Attention System of the Human Brain," *Annual Review of Neuroscience,*13, 25-42.

Raghunathan, Rajagopal and Michel Tuan Pham (1999), "All Negative Moods Are Not Equal: Motivational Influences of Anxiety and Sadness on Decision Making," *Organizational Behavior and Human Decision Processes,* 79 (1), 56-77.

Ravaja, Niklas (2004), "Contributions of Psychophysiology to Media Research: Review and Recommendations," *Media Psychology* 6 (2), 193-235.

Rayner, Keith (1978), "Eye Movements in Reading and Information Processing," *Psychological Bulletin, 85,* 618-60.

--- (1998), "Eye Movements in Reading and Information Processing: 20 Years of Research," *Psychological Bulletin,* 124, 372-422.

Rothschild, Michael and Yong J. Hyun (1990), "Predicting Memory for Components of TV Commercials from EEG," *Journal of Consumer Research*, 16 (4), 472-78.

---, Esther Thorson, Byron Reeves, Judith Hirsch, and Robert Goldstein (1986), "EEG Activity and the Processing of Television Commercials," *Communication Research*, 13 (2), 182-220.

Sayegh, Lisa, William P. Anthony, and Pamela L. Perrewé (2004), "Managerial Decision-Making Under Crisis: The Role of Emotion in an Intuitive Decision Process," *Human Resource Management Review,*14 (2), 179-99.

Smith, Michael E. and Allan Gevins (2000), "Attention and Brain Activity While Watching Television: Components of Viewer Engagement," *Media Psychology,* 6, 285-305.

Swartz, B. E. (1998), "Timeline of the History of EEG and Associated Fields," *Electroencephalography and Clinical Neurophysiology*, 106, 173-76.

Theeuwes, Jan (1994), "Stimulus-Driven Capture and Attentional Set: Selective Search for Color and Visual Abrupt Onsets," *Journal of Experimental Psychology: Human Perception and Performance,*20, 799-806.

Treisman, Anne (1964), "Selective Attention in Man," *British Medical Bulletin*, 20, 12-16.

Uleman, James S. and John A. Bargh (1989), *Unintended Thought*. New York: Guilford Press.

Vuilleumier, Patric (2005), "How Brains Beware: Neural Mechanisms of Emotional Attention," *Trends in Cognitive Sciences,* 9, 585-94.

Wegert, Tessa (2005), "Gaming 101," *Click Network*, available at http://www.clickz.com/experts/media/media_buy/article.php/3550216 (accessed November 28, 2005).

Wilson, Timothy D. (2002), *Strangers to Ourselves. Discovering the Adaptive Unconscious.* Cambridge, MA: The Belknap Press of Harvard University Press.

Yarbus, Alfred L. (1967), *Eye Movements and Vision.* New York: Plenum.

Young, Andrew W. (1998), *Face and Mind.* New York: Oxford University Press.

Zajonc, Robert B. (1968), "Attitudinal Effects of Mere Exposure," *Journal of Personality and Social Psychology,* 9, 1-27.

--- (1980), "Feeling and Thinking: Preferences Need No Inferences," *American Psychologist,* 35, 151-175.

--- (1998), "Emotions," in *The Handbook of Social Psychology*, Vol. 1, D.T. Gilbert, S.T. Fiske, and G. Lindzey, eds. New York: McGraw-Hill, 591-632.

Zaltman, Gerald (2003), *How Customers Think: Essential Insight into the Mind of the Market.* Cambridge, MA: Harvard Business School Press.

Zhang, Xi, Yuping P. Wang, Shunwei W. Li, and Luning N. Wang (2003), "Event-Related Potential N270, a Negative Component to Identification of Conflicting Information

Following Memory Retrieval,"*Clinical Neurophysiology,* 114, 2461-68.

Zurawicki, Leon and Nestor Braidot (2005), "Consumers During Crises: Responses from the Middle Class in Argentina," *Journal of Business Research,* 58, 1100-09.

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