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Application of AW and MI Indicators in Research on the Impact of Television Advertising on Audiences

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Piotr Z. Niemcewicz[1]

Abstract:

Purpose: *In today's highly competitive advertising landscape, understanding how audiences perceive and retain advertising content is essential for designing effective marketing strategies. Advertisement design, in accordance with multi-stage marketing models, can be supported by modern, precise research methods that utilise cognitive neuroscience techniques.*
Design/Methodology/Approach: *This study examines the application of neurophysiological indicators, specifically the Approach/Withdrawal (AW) and Memorisation Index (MI), to assess the cognitive and emotional impacts of television advertisements on viewers. AW reflects the degree of attention allocated to specific elements of an ad, while MI estimates the likelihood of information being encoded into long-term memory. Using electroencephalogram (EEG) recordings, participants' neural responses to selected commercials were analysed to identify patterns of attention and memory formation.*
Findings: *As one of the techniques of cognitive neuroscience, EEG can be a valuable tool for verifying the effectiveness of individual elements of an advertisement on the audience, as it allows for the precise determination of which elements arouse interest and are remembered. This makes it possible to tailor advertisements to specific audience groups by studying relatively limited groups.*
Practical Implications: *The results reveal strong correlations between attentional engagement, memory retention, and the perceived effectiveness of advertising messages. These findings provide valuable insights for marketers and content creators, highlighting the importance of aligning audiovisual content with the brain's natural processing mechanisms to enhance audience engagement and message retention.*
Originality/Value: *This study aims to fill a research gap in assessing the effectiveness of advertising on the recipient. The identified methodological gap consists of the lack of tools that allow for substantive verification of the efficacy of individual stages of models on recipients. The practical gap includes deficiencies in the pragmatic verification of the compliance of the assumed effects with theoretical models.*

Keywords: *Television advertising, neurophysiology, Approach/Withdrawal, attention, memorisation, EEG, experiment.*

JEL Code: *M31, M37, C91, D03, D91.*

[1]*University of Szczecin, Faculty of Economics, Finance and Management, Institute of Management, Poland, ORCID: https://orcid.org/0000-0002-0668-199X*
e-mail: Piotr.Niemcewicz@usz.edu.pl;

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1. Introduction

In an era of information overload and rapidly evolving media landscapes, capturing and retaining audience attention has become a central challenge for advertisers. Television advertising, despite the rise of digital platforms, remains a powerful medium for reaching broad audiences.

However, its effectiveness increasingly depends not only on creative execution but also on a deeper understanding of how viewers cognitively and emotionally engage with content. Since 1941, television has been a very popular and successful medium for advertising (Harvey, 2016).

After a decline in advertising spending in 2020 due to the pandemic, global television advertising spending returned to the growth seen in the first half of the 2020s but failed to return to pre-pandemic levels. Although traditional television's share of global advertising spending is declining year on year, spending on digital television shows no signs of slowing down.

Advertising revenue from connected television (CTV) worldwide is expected to double between 2023 and 2026. Currently, TV's share of global advertising spending is $165 billion, accounting for 22.5% of all advertising spending (Navarro, 2025).

Neoclassical economic theory traditionally posited that human behaviour is rational and predictable. However, the complexity of actual decision-making, particularly within advertising contexts, challenged this assumption and catalysed the emergence of behavioural economics.

This field emphasises the empirical study of human behaviour while accounting for cognitive and informational constraints, integrating perspectives from psychology, sociology, and cognitive neuroscience to explain systematic deviations from rational choice models. Concurrently, scholars have sought to conceptualise the mechanisms through which advertising influences consumer responses, leading to the development of formalised models of audience behaviour in market environments.

These models, introduced in the mid-19th century and refined over time, differ in their theoretical assumptions, structural stages, and sequential logic. The earliest widely adopted framework, the AIDA model, was proposed by Elias St. Elmo Lewis in 1899 (Lewis, 1899).

Recent advances in neuroscience have opened new avenues for exploring consumer behaviour beyond traditional self-report methods. Neurophysiological tools, such as electroencephalography (EEG), enable researchers to observe real-time brain activity, providing insights into attention, memory, and emotional responses.

Within this context, two key indicators have emerged: the Attention Window (AW), which reflects the degree of focus allocated to specific elements of a stimulus, and the Memorisation Index (MI), which estimates the likelihood of information being encoded into long-term memory.

This study aims to investigate how AW and MI can be applied to assess the impact of television advertisements on viewers. By analysing EEG data collected during exposure to selected commercials, we seek to identify patterns of neural engagement that correlate with perceived advertising effectiveness.

The findings contribute to the growing field of neuromarketing and offer practical implications for designing content that resonates more deeply with audiences. Electroencephalography (EEG) is well-suited for assessing the effectiveness of television commercials due to its high temporal resolution (Van Diepen, Boksem, and Smidts, 2025).

2. Literature Review

Representatives of behavioural economics will demonstrate that people are less rational than they believe when making decisions, and that the causes of human conduct should be located in brain activity. Kahneman and Tversky started comparing their cognitive models of decision-making under risk and uncertainty to economic models of rational behaviour. They have shown that for people, the negative value of loss is bigger than the positive value of profit (Kahneman and Tversky, 1979).

As a result of these changes, economists were encouraged to rethink how psychology might be applied in economic theories and models (Camerer, Loewenstein and Rabin, 2004). They outline the mechanisms underlying advertising, along with the cognitive processes involved in information processing and utilisation by recipients.

The most popular models of advertising impact are linear and consist of a combination of elements such as comprehension, emotions, and behaviour. Each of them goes through different phases (Barry and Howard, 1990), cognitive (thinking),

affective (feeling) and behavioural (Fennis and Stroebe, 2020). The persuasive capacity of advertising derives not only from its inherent characteristics and operational mechanisms but also from consumer decision-making processes in brand selection and purchase.

These influences are rooted in fundamental cognitive functions, suggesting that susceptibility to advertising is a consequence of natural mental processes rather than deliberate choice (Heath, 2003). The AIDA model exemplifies a framework comprising four sequential stages: Attention, Interest, Desire, and Action, organised across three overarching phases: Cognitive, Affective, and Behavioural, as shown in Table 1.

Table 1. *AIDA model*

Stage	Description	Phase
Attention	To attract the viewer's attention, make a positive presence in the viewer's mind, and offer the benefits of watching the rest of the ad. The consumer becomes aware of a category, product or brand.	Cognitive
Interest	To arouse the viewer's interest through the developed content of the message. The audience must be interested in the advertisement or part of it. The consumer becomes curious about learning about brand benefits & how the brand fits into their lifestyle.	Affective
Desire	Desire involves emotions that need to be stimulated. The consumer develops a favourable disposition towards the brand.	Affective
Action	Make the audience aware of their emotions or desires to elicit an immediate response. The consumer forms a purchase intention, shops around, engages in a trial or makes a purchase.	Behavioural

Source: *Author's own research based on Rawal, (2013).*

3. Research Methodology

The experiment was conducted with a group of 32 recipients (19 female and 13 male) of varying ages, ranging from 22 to 68 years old (Niemcewicz, 2023). The mean values and the standard deviations are listed in Table 2.

Table 2. *The mean values and the standard deviations for participants' age*

Sample	**N**	**M**	**SD**
Entire cohort	32	41.75	12.68
Women	19	39.95	11.35
Men	13	44.38	14.94

Source: *Author's calculations.*

The statistical data analysed for the population under study should be based on random samples large enough to provide a basis for quantitative inference so that the results can be generalised to the entire population (Borkowski, Dudek and Szczesny,

2004). Establishing an appropriate sample size is a critical methodological consideration for ensuring the validity, precision, and reproducibility of research outcomes. In experimental studies employing advertisements as stimuli, the mean participant count typically approximates 33 (Bazzani *et al.,* 2020).

A study examining the impact of reducing sample size on research outcomes identified threshold values beyond which statistical significance was maintained.

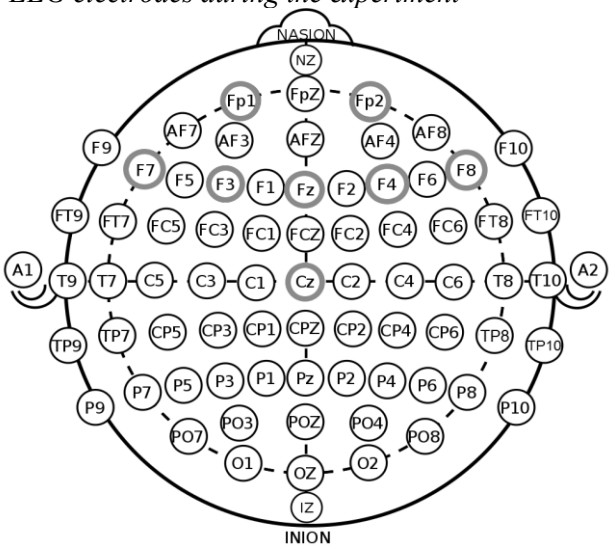
Using a reference population of 36 participants, it was deemed acceptable to decrease the sample size to 24 for experiments involving a 30-second commercial (Vozzi *et al.,* 2021). Participants in the study watched a 30-second commercial television advertisement for ice cream. The film frames (seconds) are shown in Figure 1.

Figure 1. *Film frames of the analysed advertisement*

Source: *Author's own work based on https://vimeo.com/269621878.*

While watching the advertisements, brain activity was measured using electroencephalography (EEG). The EEG measurement was performed using gel (wet) electrodes placed in accordance with the 10–20 system in a fabric cap. In the area of the frontal part of the frontal lobe, only eight electrodes were taken into consideration (Cz, Fp1, Fp2, F7, F3, Fz, F4, and F8), as shown in Figure 2.

Figure 2. *Use of EEG electrodes during the experiment*



Source: *Author's own work.*

4. Research Results and Discussion

The recorded signal was pre-processed (Piwowarski, Gadomska-Lila and Nermend, 2021) and analysed using the Matlab package with EEGLAB (Delorme and Makeig, 2004) and FieldTrip (Oostenveld *et al.,* 2011) add-ons. After filtering and cleaning the signal, the IAF (Individual Alpha Frequency) and theta frequency bands were extracted (Klimesch, 1999).

The GFP (Global Field Power) was then calculated for these bands. GFP describes the total EEG activity at specific measurement points at a particular time (1) (Lehmann and Skrandies, 1980; Lehmann and Michel, 1990). It corresponds to the standard deviation of the average EEG amplitude from the electrodes at a given moment of measurement (Vecchiato *et al.,* 2013):

$$GFP = \frac{1}{N}\sum_{i=1}^{N} x_{\vartheta_i}(t)^2 \tag{1}$$

where:

ϑ - analysed EEG band,
N - number of electrodes in the examined area
i - electrode index
x - EEG sample for time t filtered for a given bandwidth ϑ for the i-th channel.

Two indicators (AW for attention and MI for memory encoding) determining interest in the presented stimuli and memory retention were calculated from the GFP values. AW reflects the level of attention or engagement with a stimulus, while MI indicates the likelihood that information will be encoded and remembered.

The Approach/Withdrawal (AW) index is defined as the alpha frontal asymmetry index

$$AW = Average\_Power_{\alpha_{right\_frontal}} - Average\_Power_{\alpha_{left\_frontal}}$$

and is calculated based on the formula (2) (Vecchiato *et al.,* 2011; Quarto *et al.,* 2014; Smith *et al.,* 2017):

$$AW = \frac{1}{N_P}\sum_{i\in P} x_{\alpha_i}^2(t) - \frac{1}{N_Q}\sum_{i\in Q} y_{\alpha_i}^2(t) \tag{2}$$

where:

N_P, N_Q - channel cardinality
x_{α_i}, y_{α_i} - *i*-th channel EEG in the alpha band
P, Q - sets of left and right channels

The Memorisation Index (MI) was obtained from EEG electrodes placed over the left frontal part of the brain from the theta band

$$MI = Average\_Power_{\theta_{left\_frontal}}$$

and is calculated based on the formula (3) (Tulving *et al.,* 1994; Habib, Nyberg and Tulving, 2003; Vecchiato *et al.,* 2010):

$$MI = \frac{1}{N_Q}\sum_{i\in Q} x_{\theta_i}^2(t) \tag{3}$$

where:

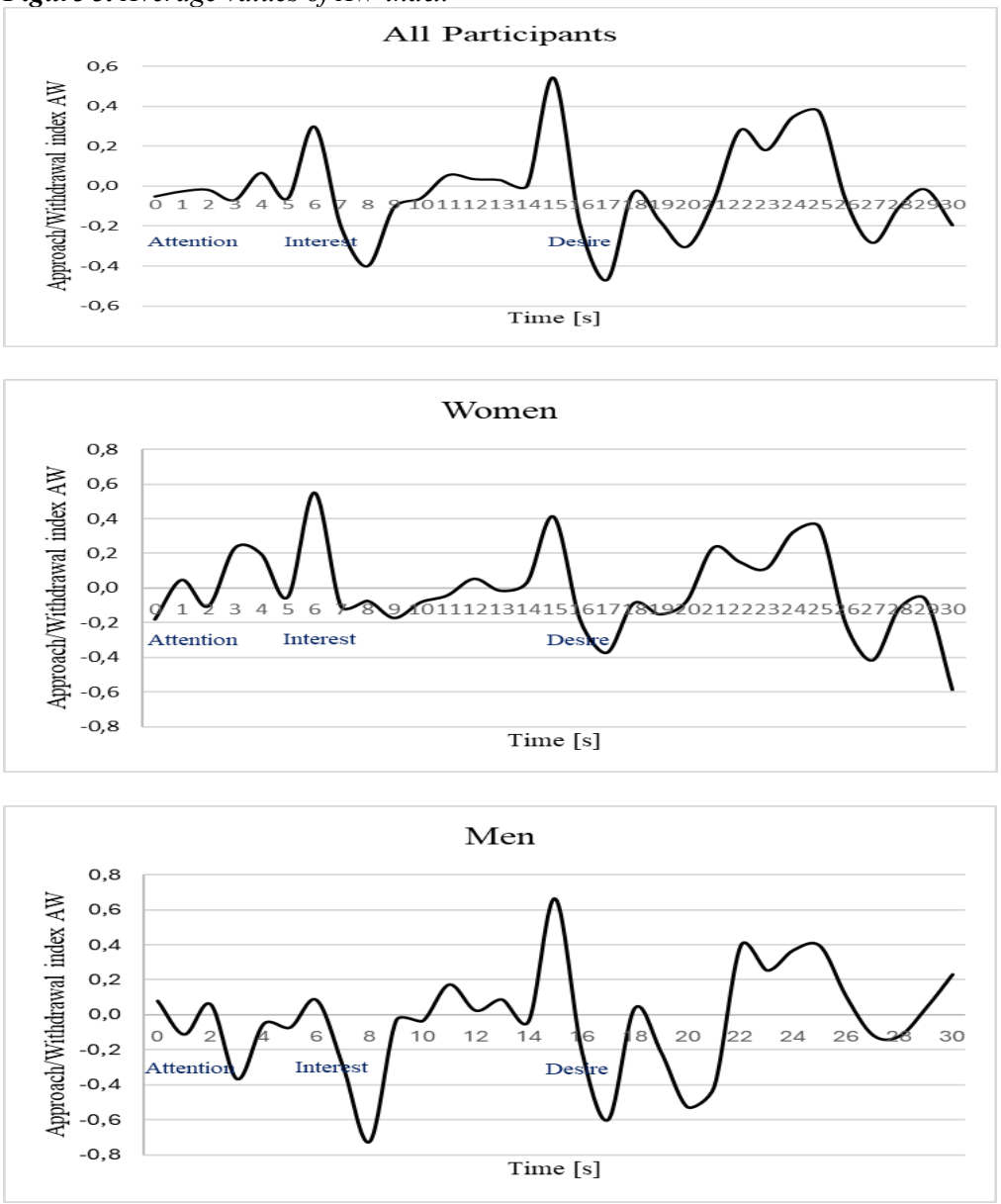
x_{θ_i} - *i*-th channel EEG in theta band
Q - set of left channels (Fp1, F3, F7)
N_Q - channel cardinality

The AW index value corresponds to fluctuations in interest, increasing as interest rates rise and declining as they fall. The recorded AW signal was processed and averaged to produce a smoothed representation of its overall trajectory (Davidson, 2004).

An increase in the MI index correlates with improved memory (Summerfield and Mangels, 2005; Werkle-Bergner *et al.,* 2006; Vecchiato *et al.,* 2013).

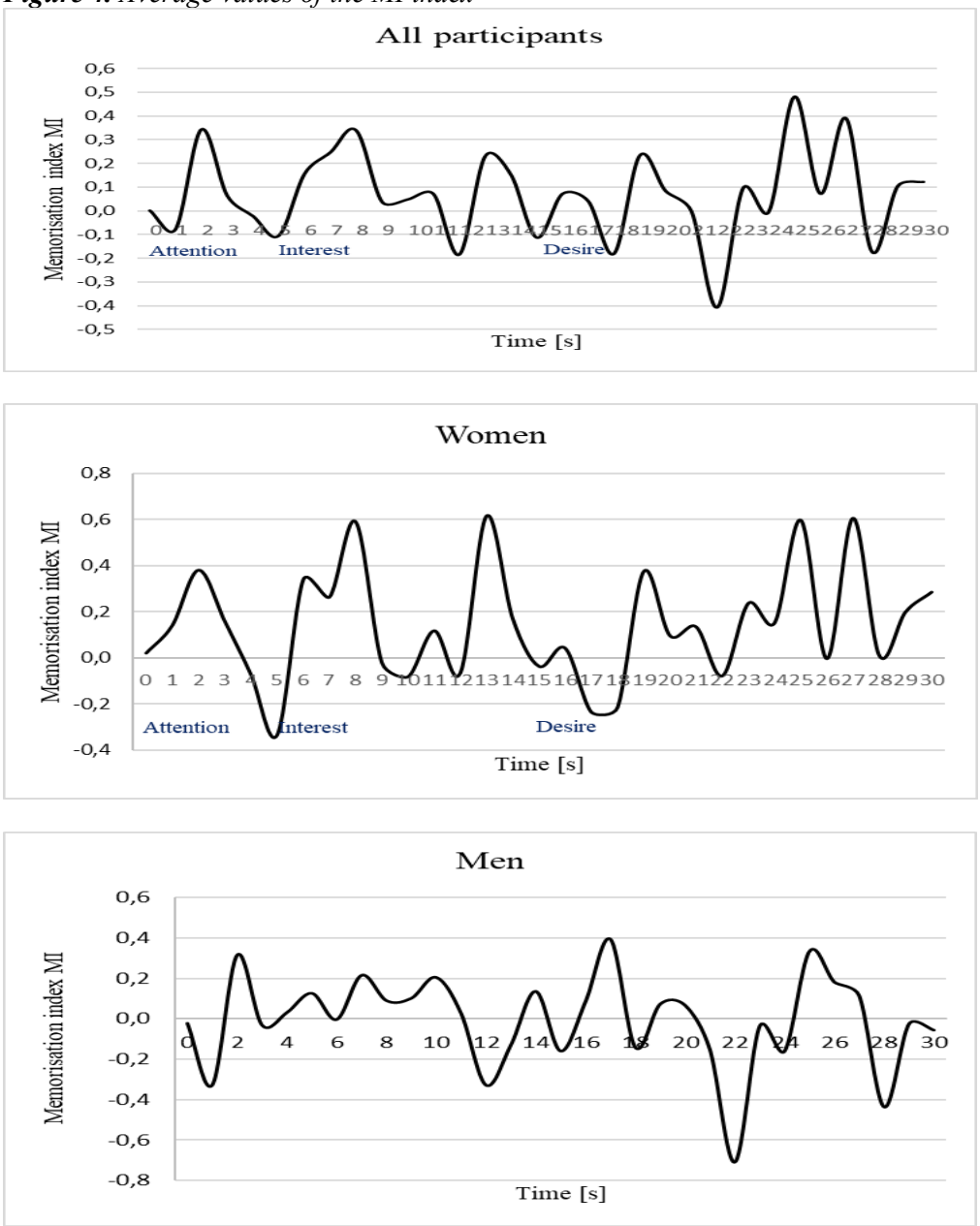
After calculating the AW and MI indexes for the entire study cohort and for women and men separately, the corresponding charts were made. The results are presented in Figure 3 and Figure 4.

Figure 3. *Average values of AW index*



Source: *Author's own research.*

Figure 4. *Average values of the MI index*



Source: *Author's own research.*

An analysis of the AW index charts reveals that different scenes elicit varying levels of interest among women and men. The first few seconds of the advert (Attention Phase) generate moderate interest. Around 3-8 seconds (Interest Phase), attention is captured, but the next segment causes a loss of interest. Intense stimulation of the audience occurs around 14 seconds (Desire Phase), but it does not last. The final part

of the advertisement evokes a generally positive attitude.

In the middle section, women react positively, but the end of the advert is less appealing to them, which may be due to fatigue or an adverse reaction to a particular scene. Men are more emotionally engaged in the middle section of the advert and maintain their interest until the end. Higher AW means greater engagement. This is essential information for advertisers.

Similar to the analysis of AW, the MI value indicates good conditions for encoding information at the beginning of the advertisement (Attention phase), which are maintained in the Interest phase. The middle part of the advertisement (approx. 13-14 seconds in the Desire phase) is less conducive to memorisation. The final content indicates good memorability.

Higher MI means better memory encoding. Women tend to show greater susceptibility to remembering content, especially during the Interest phase and the final part of the advertisement. Lower MI values in men most of the time indicate weaker memory processes in the middle part of the advertisement, with the final part only partially compensating for this effect.

5. Conclusions, Proposals, Recommendations

The study and experiment show the possibilities of using cognitive neuroscience techniques in analysing the impact of advertising on the recipient. A television advertisement was used as an example, illustrating one of the many marketing models and techniques available. The study does not complete the entire topic but only presents the methodology and available tools.

The use of EEG tests allows for generalising conclusions regarding the reception of advertising depending on the target group. Similarly, the use of other neuroscientific techniques, such as galvanic skin response, heart rate, functional magnetic resonance imaging, eye tracking, or face reading measurements, allows for the precise determination of which elements of an image attract attention the longest and which emotions they evoke.

Due to the size of the sample, the population was divided only by gender. However, it is possible to conduct future research that differentiates recipients according to other criteria, such as age or education, which requires expanding the experimental group. The use of the techniques referred to in this study enables the verification and correction of advertisement content before it is broadcast on television stations, thereby reducing the costs and risks associated with broadcasting advertisements that are not tailored to the target audience.

The AW and MI indices, when compared, clearly show that the same scenes evoke different levels of interest depending on gender. The generalised results for the entire

study group differ from the results shown in the perception of advertising by women and men. Different levels of interest also correspond to varying levels of recall. This type of knowledge is valuable to advertisers, enabling them to quickly assess further steps related to the broadcast of an advertisement.

The best moments for memorisation are the beginning and the end of the advert. Women tend to remember content more effectively and evenly, while men have greater difficulty retaining information in the middle part of the advertisement. Implications for advertising design: key information (e.g., brand, slogan) should be placed at the beginning and end of the ad. The middle section needs to be reinforced with elements that promote memorisation (e.g., repetition of the brand name, strong visual stimuli).

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