

Relation between Emotions and Memory Relate in Public Service Advertising Campaigns. A Study Based on a Neuroscience Approach

Relación entre Emociones y Recuerdo en Campañas Publicitarias
de Servicio Público. Una Aproximación desde la Neurociencia

Antonio Baraybar Fernández

Universidad Rey Juan Carlos. Spain.

antonio.baraybar@urjc.es

[CV]  

Miguel Baños González

Universidad Rey Juan Carlos. Spain.

miguel.banos@urjc.es

[CV]    

Mario Rajas Fernández

Universidad Rey Juan Carlos. Spain.

mario.rajas@urjc.es

[CV]    

How to reference this article / Standard reference.

Baraybar-Fernández, A. Baños-González, M., & Rajas-Fernández, M. (2023). Relation between Emotions and Memory Relate in Public Service Advertising Campaigns. A Study Based on a Neuroscience Approach. *Revista Latina de Comunicación Social*, 81, 1-33.
<https://www.doi.org/10.4185/RLCS-2023-1936>

ABSTRACT

Introduction: Public service advertisements are a valuable strategy for modifying attitudes and behaviors related to issues of social concern. These messages often seek an emotional response from the public, which is why neuroscience techniques are useful tools to better understand the behavior of audiences, reduce uncertainty in decision-making and develop more effective actions. **Methodology:** This study aims to determine the relationship between the emotions induced in audiovisual public service advertising messages and recall in a sample of individuals, segmented by sex, exposed to public service advertisements. In the experiment, the electrical activity of the brain, heart rate, and electrodermal response were recorded. The recall was measured through a test applied to the subjects. **Results:** With the data obtained, the Emotional Index and the Appetitive/Aversive Index were calculated to determine the emotional response and motivation, positive or negative, towards the stimuli. We

also obtained data on the subjects' spontaneous and suggested recall, as well as on the subjective emotional meaning that the stimuli provoked in the subjects: These data demonstrate the relationship between the emotional state generated by the messages and their recall; that there are differences, both in the Emotional Index and the Appetitive/Aversive Index, between men and women; and highlight the importance of taking into account other aspects of the narrative in addition to conveying an emotion.

Keywords: Neuroscience techniques; Neuromarketing; Advertising Research; Public service advertisements; Advertisement recall; Emotional Index; Approach Withdrawal Index.

RESUMEN

Introducción: Los anuncios de servicio público son una estrategia valiosa para modificar actitudes y comportamientos relacionados con temas de interés social. Estos mensajes persiguen, frecuentemente, una respuesta emocional en el público por lo que las técnicas de neurociencia se muestran como herramientas útiles para comprender mejor el comportamiento de los públicos, reducir la incertidumbre en la toma de decisiones y desarrollar acciones más eficaces. **Metodología:** Este estudio tiene como objetivo conocer la relación que tienen las emociones inducidas en los mensajes publicitarios audiovisuales de servicio público y el recuerdo en una muestra de individuos, segmentada por sexo, expuestos a anuncios de servicio público. En el experimento se ha registrado la actividad eléctrica del cerebro, la frecuencia cardíaca y la respuesta electrodérmica. El recuerdo se ha medido mediante un test aplicado a los sujetos. **Resultados:** Con los datos obtenidos se ha calculado el Índice Emocional y el Índice Apetitivo/Aversivo para determinar la respuesta emocional y la motivación, positiva o negativa, hacia los estímulos. También se han obtenido datos del recuerdo de los sujetos, espontáneo y sugerido, así como del significado emocional subjetivo que los estímulos han provocado en los sujetos. **Conclusiones:** Con estos datos se demuestra la relación entre el estado emocional generado por los mensajes y su recuerdo; que existen diferencias, tanto en el Índice Emocional como en el Índice Apetitivo/Aversivo, entre hombres y mujeres; y se pone de manifiesto la importancia de tener en cuenta otros aspectos de la narración además de transmitir una emoción.

Palabras clave: Técnicas de neurociencia; neuromarketing; investigación publicitaria; publicidad de servicio público; recuerdo publicitario; Índice Emocional; Índice Apetitivo/Aversivo.

Translation by **Paula González** (Universidad Católica Andrés Bello, Venezuela)

1. Introduction

Advertising has been a fundamental tool to educate and persuade the public on issues of social importance (Nan, 2008). This communication, similar in many ways to that developed by commercial brands, is called public service; it is a non-commercial, non-profit, social service and public interest-oriented communication (Hong, 2018), which focuses on a relevant issue to raise awareness of certain problems and their possible solutions, and often also attempt to influence beliefs, attitudes, and behaviors regarding them (O'Keefe and Reid, 2009).

These messages have the challenge of being sufficiently persuasive to induce or motivate certain behaviors in specific audiences. For decades, different research has been proposing models to improve the effectiveness of these messages. Given the multiple creative proposals, the need arises to research the effects that the different narratives used provoke in audiences (Graaf et al., 2016); and, in turn, to identify the most promising characteristics to achieve behavioral change (Chan et al., 2022). One of the strategies used is to try to elicit an emotional response in the audience (Dillard and Peck, 2000) to reduce or modify risky attitudes or behaviors since public service advertising that elicits strong emotions (positive or negative) is better remembered and perceived in a more positive way (Kuznetsova et al. 2019).

Emotions are frequently resorted to in order to create positive advertising messages and transfer these feelings to brands (Shen and Morris, 2016) so there is a clear willingness to determine and understand those emotional contents that can increase their capacity for social influence.

The problem is that the most appropriate method to measure these processes is not precisely known (Bellman et al., 2019). Thus, although, among the different emotions, fear has played a leading role in the construction of messages, there are divergent opinions about their effectiveness and whether or not they are counterproductive (Ort and Fahr, 2020).

Traditionally, research on the effects of advertising has relied mainly on surveys or interviews where consumers state how they perceive these messages. These are methods that rely on the willingness and ability of subjects to express their levels of attention, emotions, preferences, or future behaviors (Pozharliev et al., 2017) but the reality is that intention and action are not linked (Ford, 2019).

In this context, from Neuroscience we expect to obtain new specific knowledge about the unconscious and automatic processes that influence human behavior (He et al., 2021) since neuroscientific methods are presented as a very useful tool to improve the understanding of the mechanisms behind consumer behavior (Baños-González and Baraybar-Fernández, 2022) and provide a more accurate explanation of advertising success than traditional measures since they have allowed unlocking the human brain and provide information about subconscious brain processes that are closer to what really happens to consumers when they are exposed to a sales stimulus (Ienca and Andorno, 2017).

These techniques make it possible to use data obtained about the brain and neural activity to predict people's actions when exposed to marketing stimuli (Lim, 2018). They are tools that contribute to a systematic understanding of consumer behavior and the decision-making process (Alsmadi and Hailat, 2021), help to better understand how those messages are perceived and processed at both the conscious and subconscious levels (Devaru, 2018), and overcome many problems associated with traditional tools when analyzing the impact of advertising (Brennkmeijer et al., 2019) by directly probing the underlying thoughts, feelings, and intentions of the consumer (Hsu, 2017). In this way, neuroscientific techniques improve the understanding of stimulus effects on consumers (Bočková et al., 2021), without questions and without requiring their conscious participation (Baños-González et al., 2020), providing a more scientific and objective measurement, while reducing uncertainty in marketing decision-making (Daugherty and Hoffman, 2017).

They, therefore, represent an alternative or can act as a complement to conventional research techniques (Ford, 2019) by providing access to information about consumer preferences that would otherwise be hidden (Gountas et al., 2019).

Thanks to these techniques, it is possible to draw more precise conclusions applicable to product communication (Lin et al., 2018), at the same time as the psychic processes recorded with them are shown to be a more reliable means of measuring success (Tapia-Frade et al., 2016) especially because of their involvement in the generation of memory.

Knowing some of the emotional levers that are activated in the consumer makes it possible to identify those that generate a greater somatic imprint as a positive trait (Damasio, 2005) in the positioning and recall of a brand, given that it has been shown that the greater the intensity of an emotion, the greater the capacity for impact and advertising recollection.

Based on these premises, a great deal of research has been carried out using neuromarketing techniques to measure variables such as attention, emotional impact, or memory of advertising messages. As an

example, in studies on public service advertising, the following have been researched: consumers' attention, recall, and emotion when faced with the viewing of social advertising related to energy efficiency (Gordon et al., 2018); attention and donation intention in non-governmental charity advertising (dos Santos et al., 2018); the relationship between subjects' brain reaction to advertising messages about homosexuality and attitude toward the advertised topic (Maison and Oleksy, 2017); the impact of social context on consumers' neurophysiological responses when exposed to advertising messages (Pozharliev et al., 2017); the relationship between cognitive and emotional reactions and the effectiveness of advertising messages of non-profit associations (Martinez-Levy et al., 2021); the emotional response to anti-smoking advertising messages (Rath et al., 2019); the effect of recipients' perceptions of the source of the message in audiovisual pieces about alcoholism (Stanojlovic et al., 2020).

This experimental study proposes to record and quantify the degree of the different emotions generated by the ads, to identify possible cognitive differences between genders, and to interrelate the reactions recorded by individuals with the recollection capacity of the messages. In short, it represents an approach to the knowledge that emotions play in the role of persuasion.

2. Objectives

The general objective of this research is to analyze the emotional response during the viewing of public service advertising messages and its relationship with subjects' memory.

To achieve this objective, we intend to:

- Compare the emotional response of men and women during the viewing of audiovisual public service ads.
- Analyze how the use of rational and emotional messages influences subjects' motivation when viewing public service advertising messages.
- Test the influence of the use of rational and emotional content on the recall of public service advertising messages.
- Analyze the influence of positive or negative emotions on subjects' memory.
- Analyze the relationship between the approach and withdrawal motivation towards the stimulus in the subjects' memory.

3. Methodology

The study was carried out at the Biomedical Engineering Laboratory of the Universidad Rey Juan Carlos. In this experiment, the emotional reaction and memory of a sample of subjects exposed to six advertising messages, four emotional and two rational, were analyzed. Each participant arrived in a room where they were explained what the research consisted of, approved by the Ethics Committee of the University, and proceeded to sign the informed consent form. The only personal data used were gender and age.

The subjects who participated in the experiment were asked to sit in front of a computer facing the screen which, to stabilize them and serve as a baseline, was kept with neutral content for one minute. Throughout the experiment, brain activity, heart rate, and galvanic skin response were recorded.

The participants then viewed six public service messages with no separation between them to simulate the conditions of a television commercial break.

After the data recording was completed, subjects responded to a questionnaire to measure both spontaneous and suggested recollection of scenes and themes related to the ads they had previously viewed.

3.1. Subjects Sample

The experiment involved 56 subjects (24 men and 32 women) aged between 18 and 41 years (22.5 ± 4.45 years). The participants were students with different undergraduate or graduate degrees, as well as university workers. To avoid bias related to academic background, none of the subjects were enrolled in communication degrees.

After recording the signals, a manual review of the data was carried out, discarding 15 subjects with deficiencies in signal quality to ensure the validity of the data obtained and the scientific rigor characteristic of research in clinical medicine, so that, finally, a data set of 41 subjects (18 men and 23 women) was available.

3.2. Stimulus Selection

In the experiment, six ads with specific characteristics were used to minimize the effects of extraneous variables on the results obtained:

- Subject matter: public service announcements.
- Duration: between 45 and 60 seconds.
- Advertisers: institutions unknown to the research participants.
- The ads had not been broadcasted in the subjects' environment (Spain).

A group of experts (four from academia and four from advertising) chose the six stimuli from a series of 45 audiovisual ads that met the established criteria: four were representative of four emotions (surprise, sadness, disgust, and anger) and two were rational. The former are ads that appeal to the audience's feelings and emotions, while the latter focus on the basic benefit and inform about the characteristics of the brand, product... (González-Oñate et al., 2019).

The order of presentation of the ads was established randomly to minimize the influence of primacy (beginning of the block) and recency (end of the block) effects on the recall results obtained. According to the Serial Position Effect, the position in which a stimulus is presented to the receiver influences its recollection, being more beneficial for items placed at the beginning and end of the block (Rodero-Antón, 2014; Wang et al., 2019).

The six ads that served as experimental stimuli were:

- Emotional:
 - o “No Brainer”. Asco. New Zealand Society on Alcohol and Drug Dependence. 60”.
 - o “Other people make mistakes”. Tristeza. New Zealand Government. 60”.
 - o “Friends”. Sorpresa. Qtv. 47”.
 - o “Break the Cycle”. Ira. Barnardo’s. 60”.
- Rational:
 - o “Reconstruction”. Transport Accident Commission. 60”.
 - o “Every hour”. National Institute on Drug Abuse. 60”.

3.3. Physiological Signal Recording and Analysis Methodology

William James, one of the fathers of modern psychology, elaborated, at the end of the 19th century, one of the most influential theories on the nature of emotions. His central thesis is that an emotion is a conscious perception of bodily changes associated with emotional episodes; consequently, an emotion cannot be conceived without specific bodily sensations. Emotions are phenomenological states so from the recorded bodily change we can identify the emotional state.

The ECG (electrocardiogram) and EDA (electrodermal activity) signals were recorded using the BITalino system, with a sampling frequency of 1 kHz.

The electrocardiogram (ECG) electrically records the heartbeat and reveals the rhythm and strength of our heartbeat which can be linked as evidence of physiological, emotional, or psychological arousal. The ECG was recorded using a three-electrode lead, with the positive and negative electrodes placed on the wrists, and the reference electrode on the subject's forearm. This identifies heart rate variability (HRV), using RR interval variability, which allows the characterization of autonomic nervous system (ASN) activity.

Galvanic skin response is a measure of electrodermal activity, specifically, of the conductance of our skin from perspiration. Sweating is an operation regulated by the Autonomic Nervous System that plays a fundamental role in the thermoregulation of the human body, but it also manifests as a bodily reaction of the person's arousal (peakarousal), making it an indicator of psychological or physiological arousal (Modica et al. 2018). By measuring the level of sweating, in stable environmental conditions, EDA seeks to become the evidence of a stimulated state that exceeds the deliberate control of the person, being able to register subtle and imperceptible changes self-consciously. In this research, the EDA signal was recorded by placing a pair of electrodes on the palm of the non-dominant hand; subsequently, it was processed using proprietary software developed in Python.

Lastly, an electroencephalogram (EEG) was used, being the most sophisticated technology in common use. By placing sensors on the head, it measures the electrical activity of the cerebral cortex. The frequencies emitted in this area are recorded, especially in the prefrontal part of the brain related to emotional experience and expression, as well as in decision-making processes. Using different algorithms, the frequency is translated into a series of emotional indicators, positive or pleasant stimuli and negative or unpleasant stimuli, and cognitive indicators to measure the degree of attention and the mental effort of decoding performed. The recording of brain electrical activity (EEG) was performed using a BrainProducts R digital monitoring system, with an actiCHamp signal amplifier and an actiCAP Xpress Twist helmet with 32 electrodes placed according to the international 10-20 system. Signals were recorded at a sampling rate of 500 Hz. Each signal was filtered to remove power line noise with a notch filter centered at 50 Hz. Subsequently, bandpass signals between 2 and 50 Hz were filtered and ocular and cardiac signal artifacts were removed using independent component analysis (ICA) (Cartocci et al., 2017).

3.3.1. Emotional index (EI)

It is calculated from the Galvanic Skin Response and Heart Rate signals that reflect the emotional response to stimuli, obtaining a monodimensional variable that provides information about the emotional state of the subjects (Modica et al. 2018). Several studies have highlighted that these two autonomic parameters correlate with valence and arousal (Vecchiato et al., 2014), reflecting information related to valence by heart rate (positive or negative) and arousal by galvanic skin response (low or high activation) (Cartocci et al., 2017; Modica et al., 2018). Negative values are related to negative emotions and positive values are to positive emotions.

To have a monodimensional variable, the emotional state of a subject is described using the following formula (Vecchiato et al., 2014):

$$EI = 1 - \frac{\beta}{\pi}$$

where

$$\beta = \begin{cases} \frac{3}{2}\pi + \pi - \vartheta & \text{if } GSR_z \geq 0, HR_z \leq 0, \\ \frac{\pi}{2} & \text{otherwise} \end{cases}$$

GSRZ, HRZ represent the scoring variables Z of GSR and HR; ϑ , in radians, is measured as arctan (HRZ, GSRZ). Thus, the angle β is defined to obtain the EI varying between [-1, 1].

3.3.2. Appetitive/Aversive Index (AWI)

The Appetitive/Aversive theory considers that both approach and withdrawal are two basic response patterns present in any complex adaptive response. In the case of vertebrates, these mechanisms are mediated by the two branches of the autonomic nervous system.

Spielberg et al. (2008) report a model proposed by Davidson in 1983 where the left prefrontal cortex (PFC) is involved in a system that facilitates approach behavior to appetitive stimuli, while the right PFC is involved in a system that facilitates withdrawal behavior from aversive stimuli.

Along these lines, different studies highlight an increase in left CPF activation during positive motivation and an increase in right-sided activation during negative motivation (Modica et al., 2018).

The Appetitive/Aversive Index is calculated as the difference between the average EEG power of the right and left channels in the alpha band (Vecchiato et al., 2014). Positive values of the index signify an approaching motivation towards the stimulus, while negative values indicate a tendency to withdraw.

The formula used to calculate this index is (Vecchiato et al. 2014):

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

$$= \text{Average Power}_{\alpha_{\text{right,frontal}}} - \text{Average Power}_{\alpha_{\text{left,frontal}}}$$

where: x_{α_i} and y_{α_i} represent the i -th EEG channel in the alpha band recorded from the right and left frontal lobes, respectively; P and Q are the sets of right and left channels; and NP and NQ represent their cardinality.

AWI and EI were standardized per subject (0 average value and 1 standard deviation) so that measurements could be compared. Scientific notation, frequently used in scientific and mathematical works to express, in abbreviated form, quantities with a large number of digits, was used for the data.

3.3.3. Measurement of memory

Memory is one of the most widely used variables to measure advertising effectiveness and different research has shown that memory and emotion are interconnected. Moreover, memory is a valid measure for both emotional and rational advertising (Mehta and Purvis, 2006).

After data recording was completed, participants responded to a questionnaire to measure both spontaneous and suggested recall. The purpose of using this instrument is to know the relationship between the measures obtained with neuroscience techniques and the subjects' recollection.

Spontaneous recall allows information to be retrieved directly without resorting to any reinforcement. To measure assisted recall, a series of cues or clues are used to facilitate the subjects' memory.

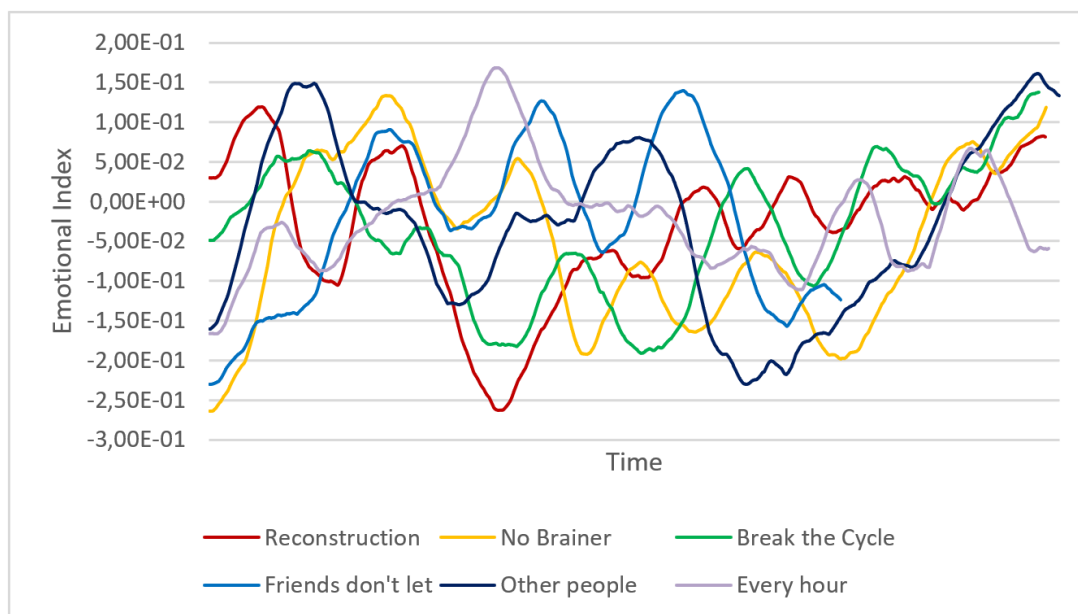
4. Results

The experimental group was divided into two subgroups, women (23 subjects) and men (18 subjects) for gender analysis.

4.1. Emotional index (EI)

Figure 1 shows the temporal evolution of the EI in each of the six ads selected for the experiment. The graph shows the differences in the emotional state of the subjects generated by the messages, both in valence (positive or negative) and activation (low or high). This image shows the predominance of the negative EI, derived from the results obtained by the heart rate, with higher activation in the negative part of the graph, established from the data obtained by the galvanic response of the skin. This tendency is maintained in both rational and emotional ads and is independent of the predominant emotion: disgust, sadness, surprise, and anger.

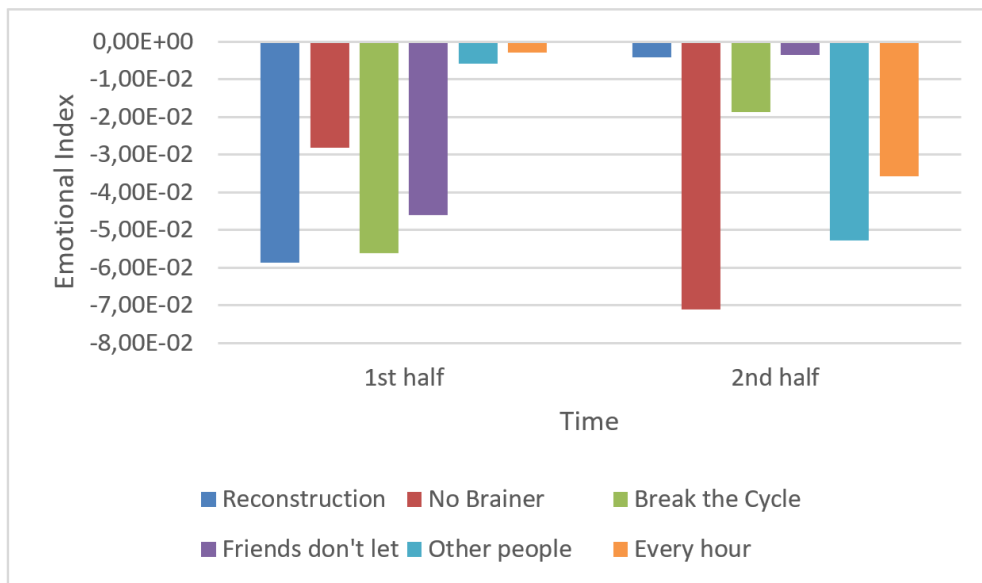
Figure 1. Representation of the temporal evolution of the EI throughout the messages analyzed.



Source: Own elaboration.

This situation is also shown in Figure 2, where the average values of the two halves of the selected ads are shown.

Figure 2. Average EI values in the first and second half of the analyzed messages.



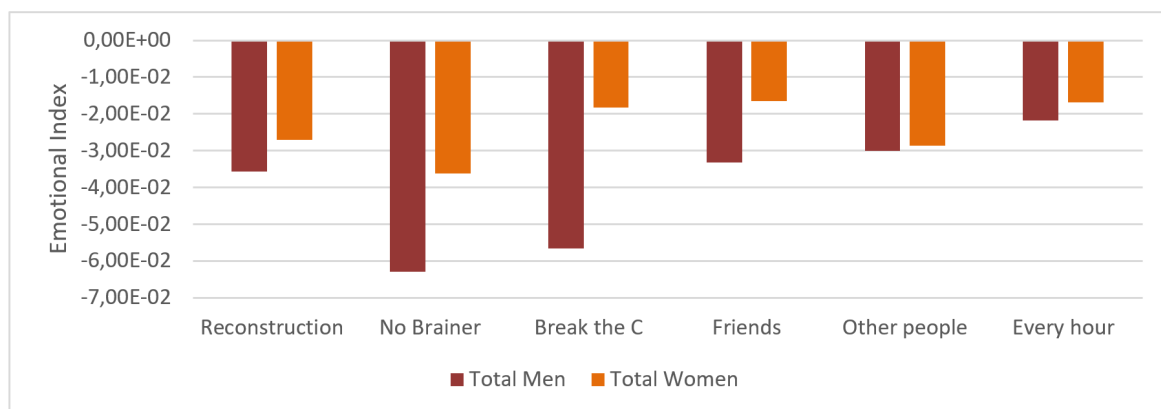
Source: Own elaboration.

In all cases, the average EI values are negative, although it is observed that the average value of one of the two halves of some ads is very close to zero: the second half of "Reconstruction" (-4.16E-03), the first half of "Every hour" (-2.89E-03), the second half of "Friends" (-3.53E-03), and the first half of "Other people..." (-5.89E-03); this indicates a negative valence with low activation.

4.1.1. Analysis of EI by gender

When analyzing the EI variations in the six ads separately, differences are observed between the two groups during the viewing of the messages. Although in the average values for the messages as a whole, the valence is negative in all cases in both men and women, the galvanic skin response shows that activation is lower in women than in men in all ads (Figure 3).

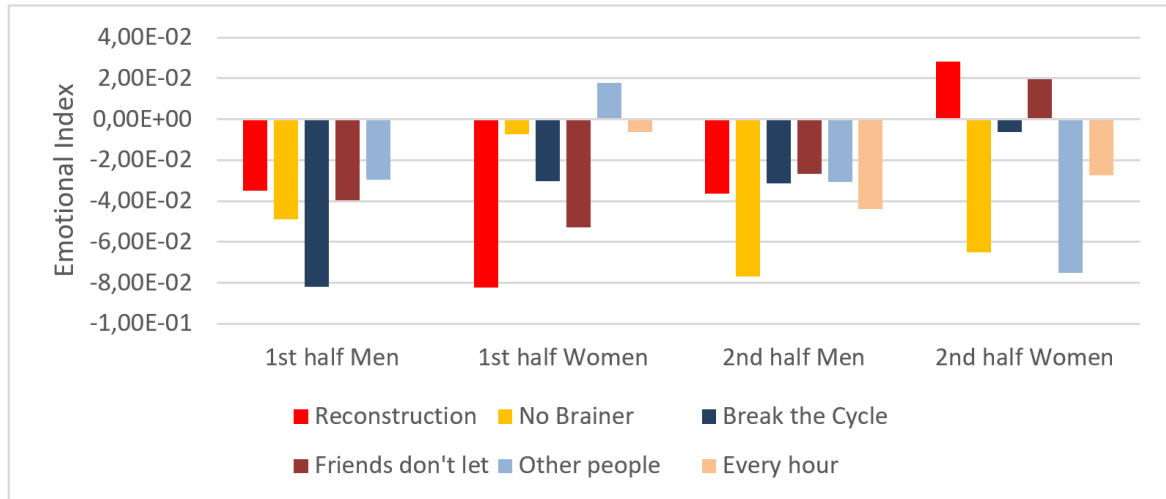
Figure 3. Average EI values in the analyzed messages differentiated by gender.



Source: Own elaboration.

When analyzing the average EI differentiating between the first and second half of the message (Figure 4), in men the results are negative in practically all ads (only in the first half of "Every hour" the EI is slightly positive: 4.74E-04), while in the case of women, there are three positive averages (first half of "Other people" and the second half of "Reconstruction" and "Friends").

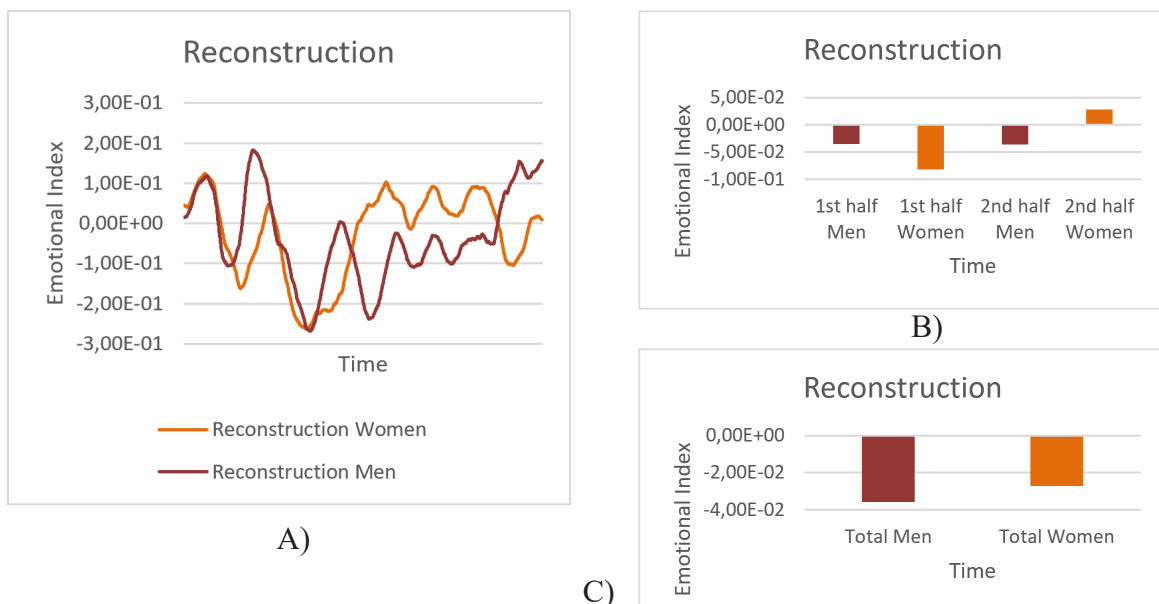
Figure 4. Average EI values in the first and second half of the messages analyzed, differentiated by gender.



Source: Own elaboration.

When analyzing the results of each message separately, in "Reconstruction" the total EI is negative for both males and females (Figure 5c), although in the averages by halves (Figure 5b) the activation of females is higher than that of males as shown by the negative EI in the first part of the message.

Figure 5. Representation of the variations of the EI of the message "Reconstruction" (Rational) between men and women. A) Temporal evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.

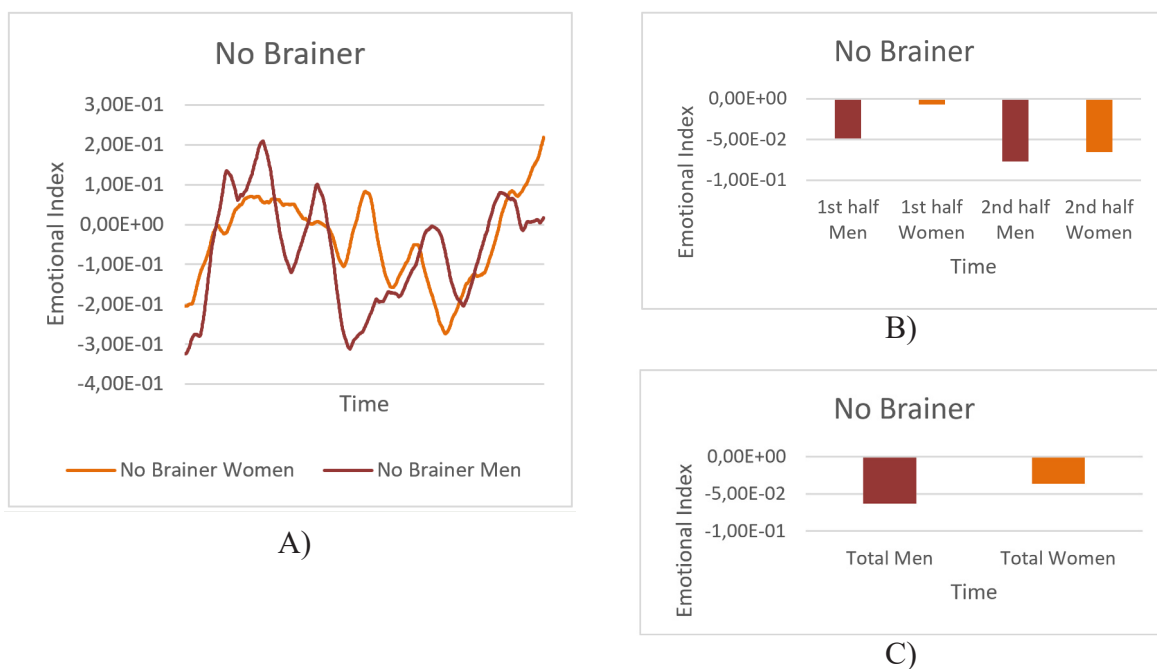


Source: Own elaboration.

The first part shows the result of a hit-and-run accident, with shocking images, caused by a driver driving at excessive speed. On the contrary, in the second part, when the result of the same accident at a moderate speed, without serious consequences, is shown, the valence of the EI in the group of women is positive, while in the case of men, it remains negative.

In the "No Brainer" message, the predominant valence is negative (Figure 6a). Although the EI begins to rise towards positive values when the action takes place in a nightclub when the preparations for consuming drugs in a toilet and manipulating their brain begin, the index shifts to negative values, especially in the case of men. This causes the average EI in the second half of the ad to have a marked negative valence in both groups (Figure 6b). In the first part of the ad, the EI of the female group has fewer negative values than that of the male group (lower activation as shown in Figures 6b) and 6c).

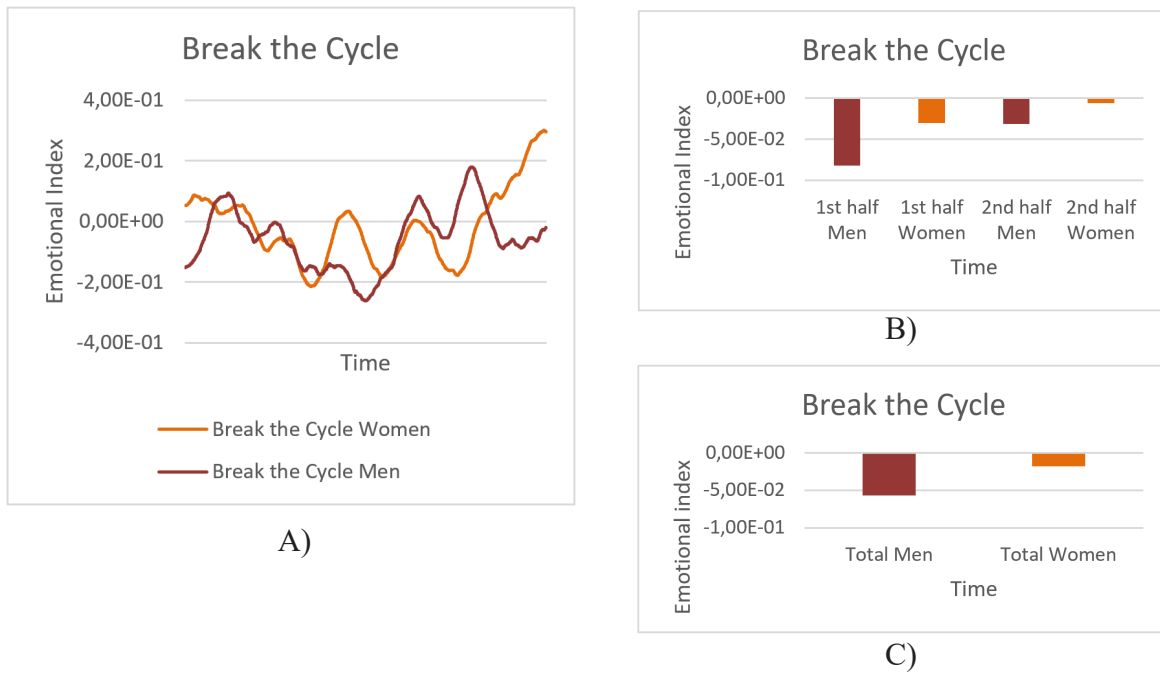
Figure 6. Representation of the variations of the EI of the message "No Brainer" (Disgust) between men and women. A) Temporal evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.



Source: Own elaboration.

In the "Break the Cycle" ad, the EI is negative. In Figure 7a) we see how the evolution of the index throughout the message shows differences by gender, especially at the beginning and end of the message. In the case of women, the EI starts with positive valence, but drops since the first seconds (the images show the aggression of a young girl in the street), remaining in negative values until the last seconds of the video when a solution to the problem is given. In the group of men, the EI starts with negative values, rises during the first seconds (the aggression) to return to negative values when the young girl is in a cell; it rises from the 40th second when the scenes are repeated at a very fast pace to fall to negative values at the end of the message. This evolution is reflected in the average EI values during the first and second half of the ad (Figure 7b) and 7c), with higher activation in the group formed by men, both in the first half and in the second half.

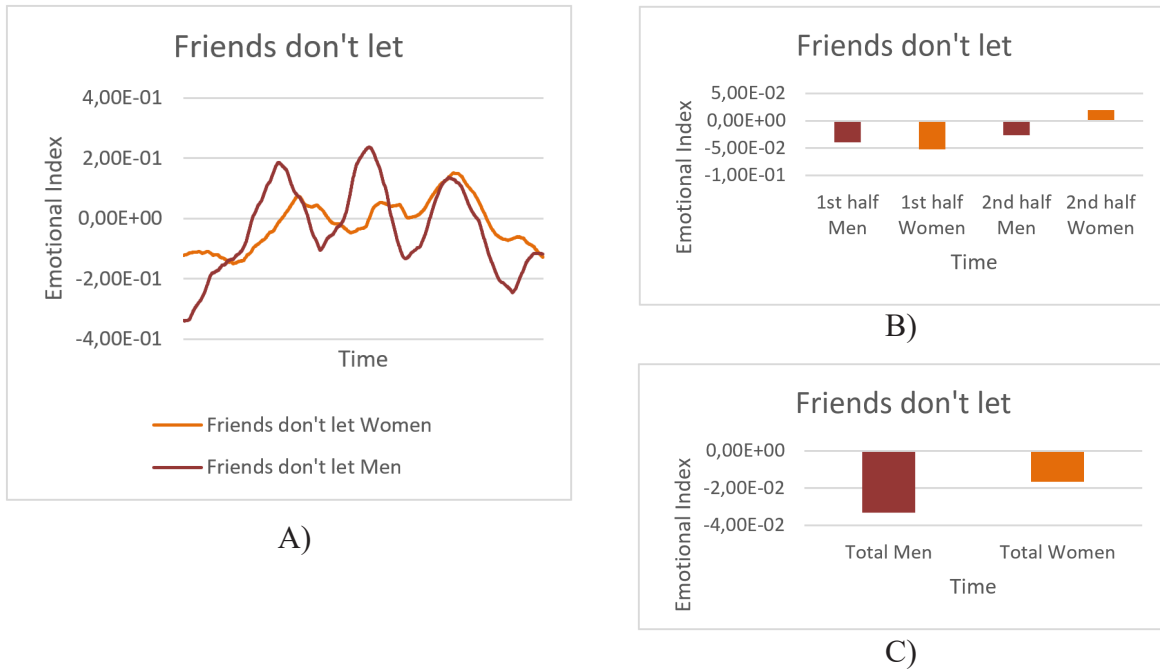
Figure 7. Representation of the variations of the EI of the message "Break the Cycle" (Anger) between men and women. A) Time evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.



Source: Own elaboration.

In the "Friends" ad, we observe, once again, a different EI for the female and male groups (Figure 8). The index for the women's group remains at similar values throughout the video, except at the beginning (arrival of a couple at a party) and at the end of the ad (ending with a shot to the couple's head by their friend), where the values are clearly negative. The EI of the men's group shifts from one valence to another continuously and with high activation: it starts at negative values, rises in the first part of the party, drops to negative values in the second part of the party to rise again while two friends are drinking while sitting on the terrace, drops when the friends say goodbye and during the shooting scenes. These changes in valence are reflected in the average values for the first and second half of the ad (Figure 8b); in the female group, the EI of the first half is clearly negative while that of the second half is positive; in the case of males, the EI is negative in both halves. Finally, the average EI for the whole ad is negative in both groups of subjects (Figure 8c).

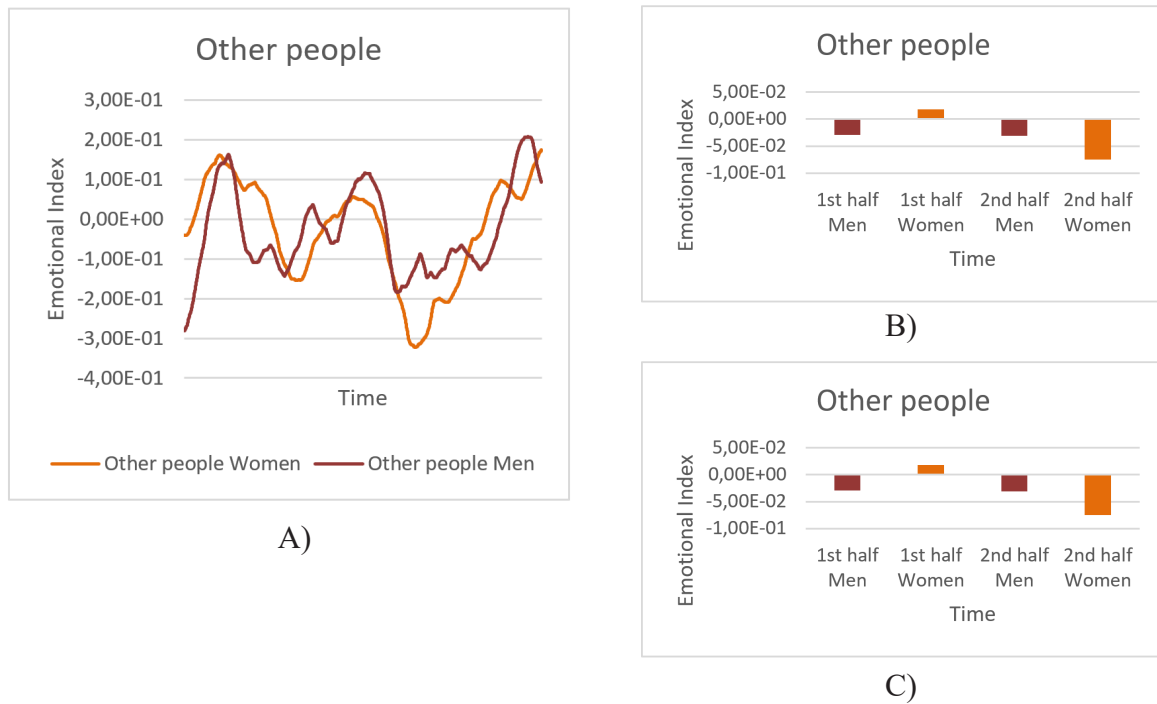
Figure 8. Representation of the variations of the EI of the message "Friends" (Surprise) between men and women. A) Time evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.



Source: Own elaboration.

The evolution of EI throughout the "Other people..." ad follows similar trajectories in the male and female groups (Figure 9a). In this story of a traffic accident that could have been avoided if one driver had paid more attention and the other had moderated his speed, we observe how in both groups the EI starts at negative values and rises as we see what seems to be a tragic car accident at an intersection. Thereafter, the EI changes valence as the drivers see the impossibility of avoiding the accident. The EI returns to positive values in the last seconds of the ad when drivers, back in their cars, expect the violent accident. In the average values (Figure 9b), in the female group, the EI of the first half is positive and that of the second half is negative; in the male group, the EI is negative in both halves. Finally, the average EI for the whole ad is negative in both groups (Figure 9c).

Figure 9. Representation of the variations of the EI of the message "Other people..." (Sadness) between men and women. A) Temporal evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.



Source: Own elaboration.

The evolution of EI throughout the "Every hour" ad, rational message, maintains the differences between the female group and the male group (Figure 10a).

Figure 10. Representation of the variations of the EI of the message "Every hour" (Rational) between men and women. A) Time evolution of EI by gender throughout the ad. B) Average EI values by gender in the two halves of the message. C) Average EI values by gender in the message.



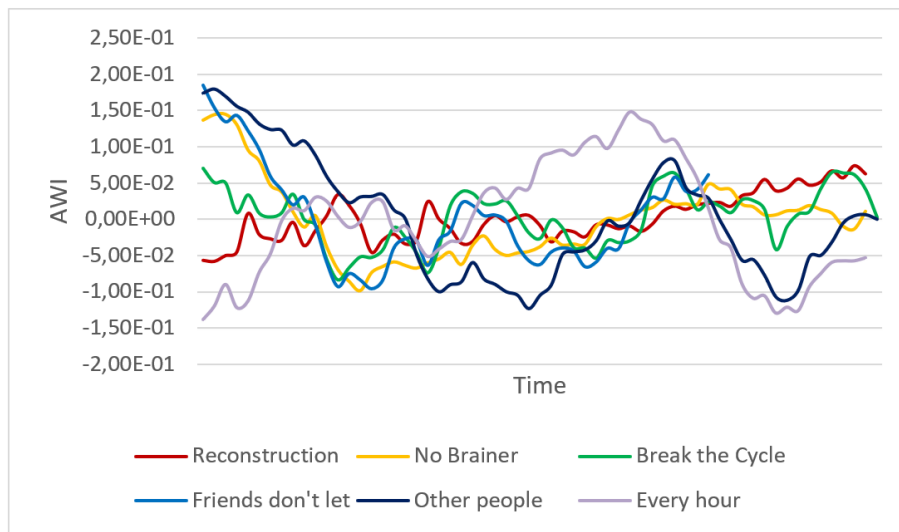
Source: Own elaboration.

In the first 10 seconds of the ad, three young people talk to the camera about their addictions; from that moment on, until the 40th second, it is a health worker who talks to the camera with texts written next to him; it ends with 5 seconds of a young man telling his experience. The biggest EI occurs in the men's group while the health worker is speaking and the text appears: "Someone dies... or they hurt others. Addiction is a disease!" In line with this evolution of EI during the ad, the first part shows values very close to zero in both men and women (Figure 10b) and, in the message as a whole, the EI is negative (Figure 10c).

4.2. Approach/Withdrawal Index (AWI)

Figure 11 shows the temporal evolution of the AWI in each of the six ads analyzed in the experiment, showing significant variations in the set of messages analyzed.

Figure 11. Representation of the temporal evolution of the AWI throughout the messages analyzed.

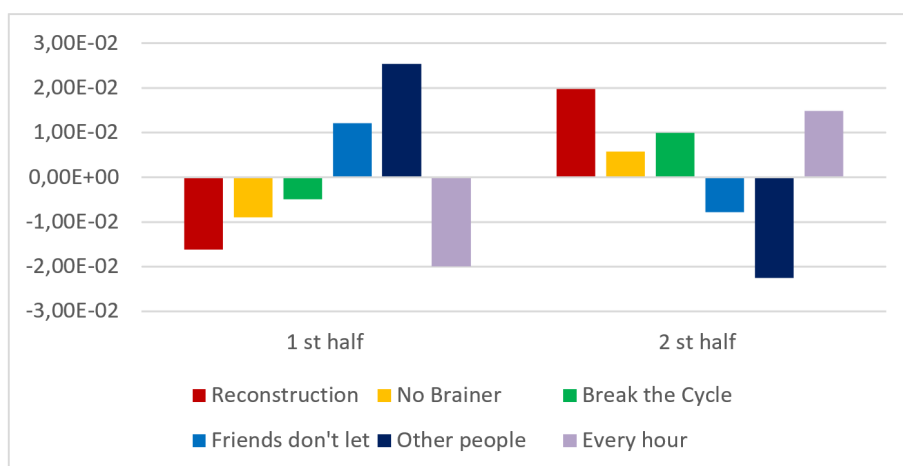


Source: Own elaboration.

This graph shows the differences in brain activity between the left prefrontal cortex (positive motivation towards the stimulus) and the right prefrontal cortex (negative motivation in response to the stimulus).

In Figure 12, where the average values for the first and second half of each ad are plotted, we can see these variations since the average of the first half is negative for four messages and the average of the second half is positive for four of them. It is striking that the motivation, positive or negative, is different in the first and second half of all the stimuli presented. In four of the ads, subjects show a negative motivation (withdrawal) towards the first part and a positive motivation (approach) in two messages; towards the second half, the motivation is the opposite in all presented stimuli.

Figure 12. Average AWI values in the two halves of the analyzed messages.

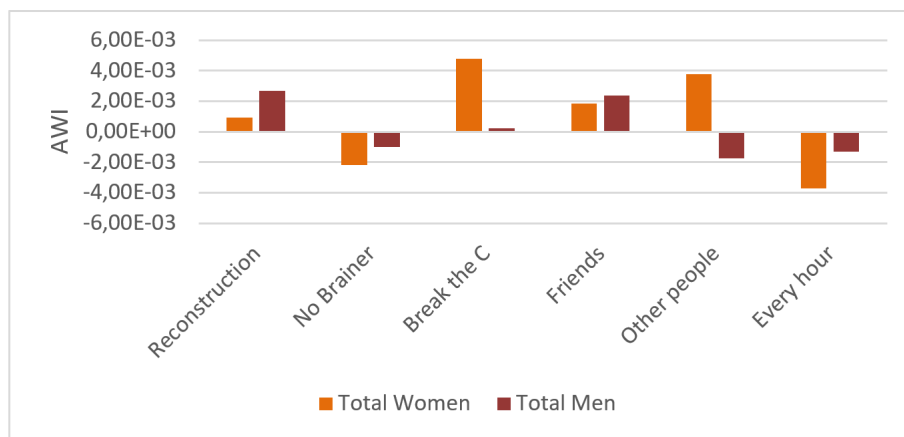


Source: Own elaboration.

4.2.1. Analysis of AWI by gender

When analyzing the variations of the AWI in each ad separately, the differences between the male and female groups during the viewing of the messages are observed. In Figure 13, we see how the average AWI values in the different messages, which show the asymmetry in brain activity between the left and right prefrontal cortex, have positive and negative values in the case of both the male and female groups. It is also observed that except in the case of "Other people...", the sign of the asymmetry is the same for both genders, although its intensity is different in both groups. Only two stimuli present negative values in both parts of the message ("No Brainer" and "Every hour").

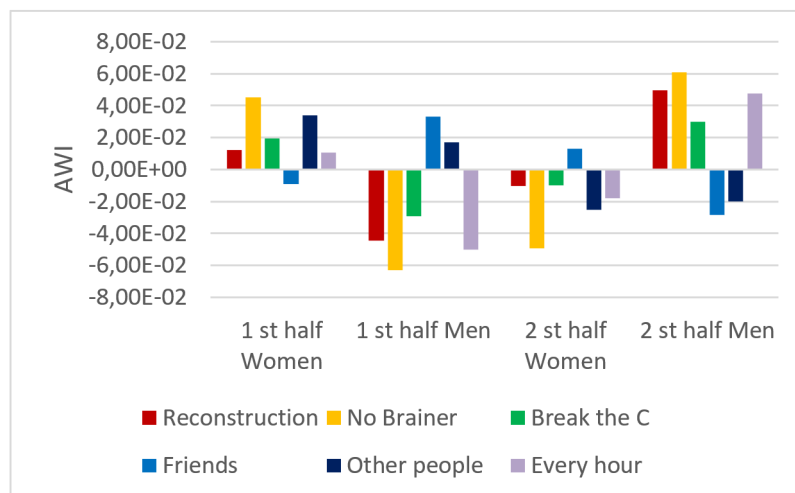
Figure 13. Average AWI values in the analyzed messages differentiated by gender.



Source: Own elaboration.

If we focus on the average AWI differentiating between the first and the second half of the message (Figure 14), exactly half of the values are negative and half positive, both among men and women, although the results between the two groups are very different: in the first half, five values in the men's group are positive and only two in the women's, coinciding in the sign of the index in only one ad ("Other people"); for the second half, the index is positive in four ads in the women's group and only one in the men's, coinciding, again, in the sign of the index in the "Other people" ad.

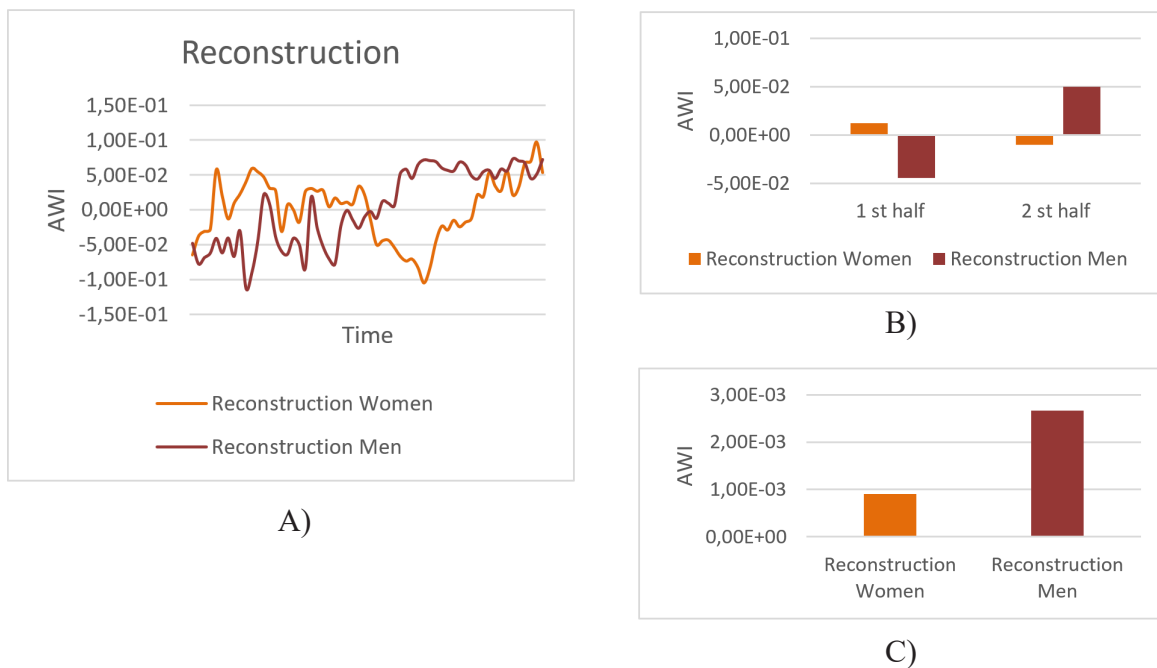
Figure 14. Average AWI values in the two halves of the messages analyzed differentiated by gender.



Source: Own elaboration.

Focusing on each ad, in the case of "Reconstruction" we observe how the asymmetry presents notable differences since in the first half of the ad there is a predominance of activation of the left prefrontal cortex (positive motivation) in the group of women, and the right side (negative motivation) in the case of men. These differences are maintained but with the opposite sign, between seconds 34 to 50 (Figure 15a).

Figure 15. Representation of the variations of the AWI of the message "Reconstruction" (Rational) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.

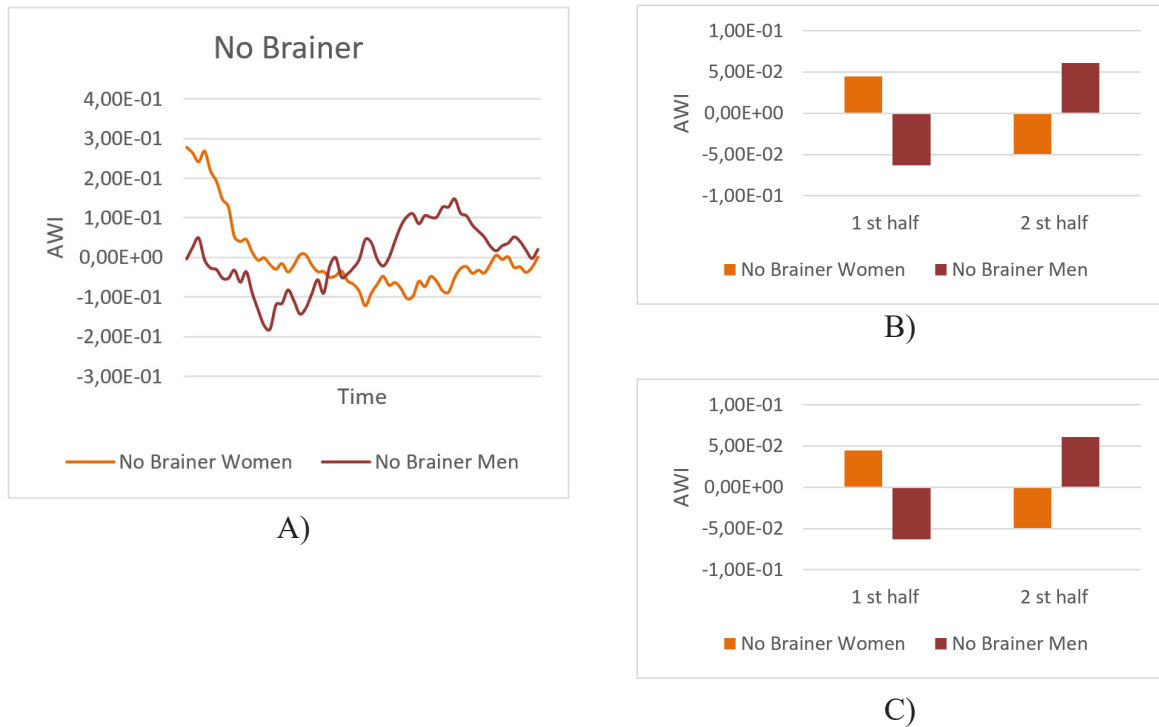


Source: Own elaboration.

When analyzing the AWI values in the first and second half of the ad, the differences by gender are clearly observed (Figure 15b) since in both halves the sign of the index is different in men and women; however, in the ad as a whole (Figure 15c), in both groups, the AWI is positive, although with different intensities: women (9.04E-04) and men (2.66E-03).

In the "No Brainer" message, we see the evolution of the AWI throughout the ad (Figure 16a), with notable differences in frontal alpha asymmetry between the male and female groups. Women start with positive values that fall during the first half of the ad until reaching negative values, a sign that is maintained throughout the second half; on the contrary, in the group formed by men, the situation is practically the opposite as observed in the average values of the two halves of the message (Figure 16b). In the ad as a whole (Figure 16c), the values of both groups are negative: women (-2.17E-03) and men (-9.92E-04).

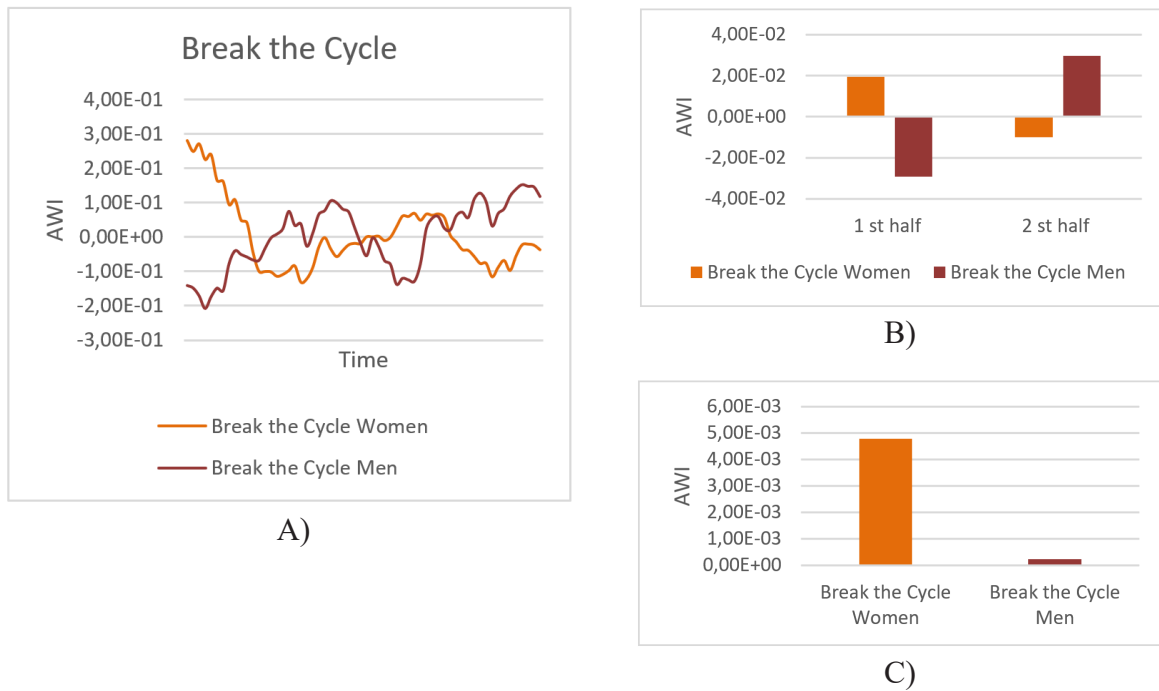
Figure 16. Representation of AWI variations of the message "No Brainer" (Disgust) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.



Source: Own elaboration.

In the "Break the Cycle" ad, the temporal evolution of the AWI is different between men and women (Figure 17a); in the case of women, it starts with positive values, goes down to negative, returns to positive, and ends with an increase in the activation of the left prefrontal cortex; on the contrary, in the group of men, the values start in negative, go up to positive, go down again, and end with an increase in the activation of the right prefrontal cortex. When analyzing the AWI averages between the two halves of the video (Figure 17b), these differences are clearly seen, although in the AWI set by groups (Figure 17c) the values are positive, although, in the case of men, the value is very close to 0 (2.36E-04).

Figure 17. Representation of the variations of the AWI of the message "Break the Cycle" (Anger) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.

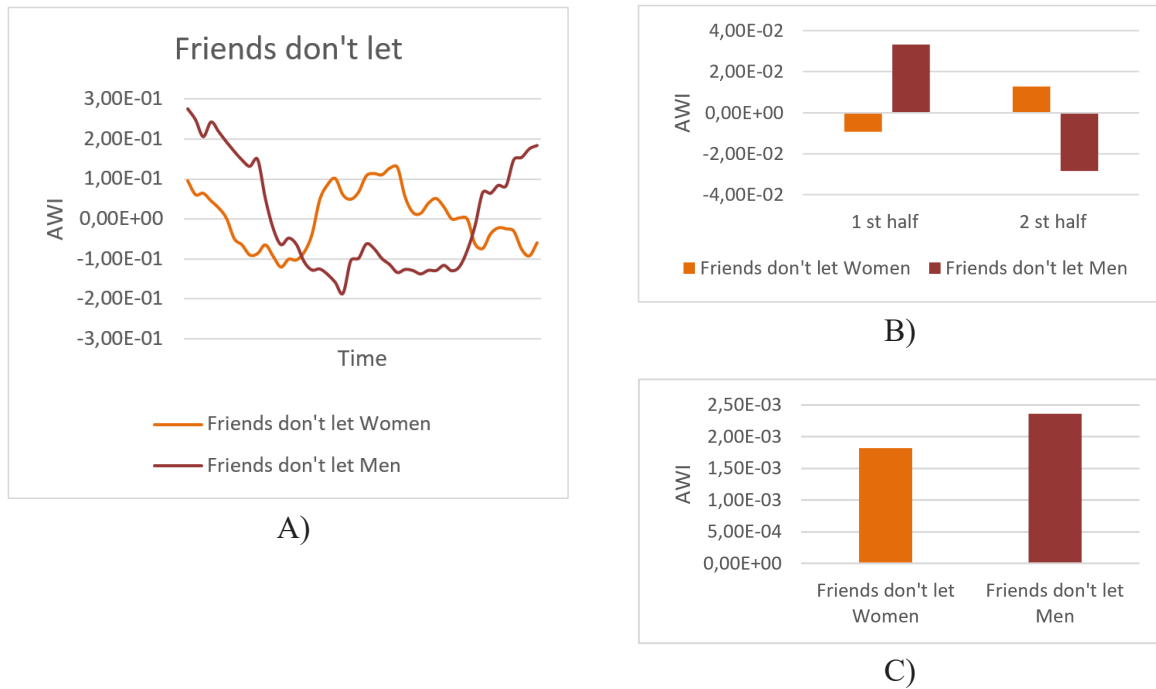


Source: Own elaboration.

In "Friends", both groups start with positive values, although lower in the case of women, and fall almost in parallel during the first 15 seconds of the video (Figure 18a), at which point the AWI is completely different between the two groups: in women it rises and remains positive until second 37, remaining in negative values until the end; the group of men remains in negative values until second 38, ending the index in positive.

This situation is seen in the graph with the average values of the two halves of the message (Figure 18b), although the AWI of the ad as a whole is positive in both groups (Figure 18c).

Figure 18. Representation of the variations of the AWI of the message "Friends" (Surprise) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.



Source: Own elaboration.

In the evolution of the AWI throughout the ad "Other people..." (Figure 19a) we observe that the two groups start in positive and go down during the first part of the message; until the second 37 the index of the women's group remains around 0 and the men's group at positive levels, at which point the index of the two groups behaves similarly until the end of the video.

This behavior can be seen in the analysis of the average values of the two halves of the message (Figure 19b) where the AWI of the two groups is positive in the first half and negative in the second half, although in the average of the message (Figure 19c) that of the women is positive (3.78E-03) while that of the men is negative (-1.74E-03).

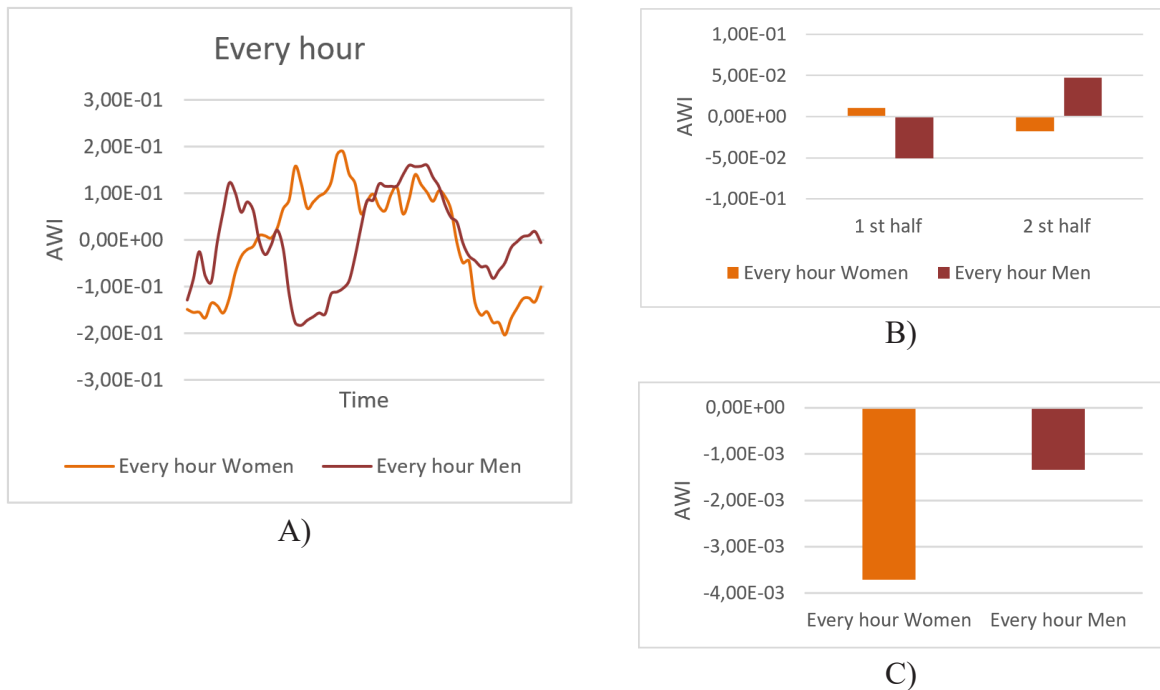
Figure 19. Representation of the variations of the AWI of the message "Other people..." (Sadness) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.



Source: Own elaboration.

Finally, in the "Every hour" ad, there are similarities in the evolution of the AWI in both groups (Figure 20a) except in the central part of the video (between seconds 16 and 30) where the values of the women's group are clearly positive while the men's group moves in negative values.

Figure 20. Representation of AWI variations of the message "Every hour" (Rational) between men and women. A) Temporal evolution of AWI by gender throughout the ad. B) Average AWI values by gender in the two halves of the message. C) Average AWI values by gender in the message.



Source: Own elaboration.

Despite the similarities, the intensity of the asymmetry is different in both groups as observed when analyzing the average values of the video halves (Figure 20b), where we find that the first half is positive for women and negative for men, and the opposite in the second half; however, in the ad as a whole, the AWI is negative for both women (-3.72E-03) and men (-1.33E-03).

4.3. Memory

Recall of the messages conveyed by the ads. All the participants in the experiment remember messages conveyed by the ads viewed; however, not all of them actually remember the topics on which these ads focus since, for example, four subjects claim to remember a message about gender violence, a topic that does not appear in any of the videos. For this reason, we only take into account the responses that do incorporate the messages that these ads actually include; thus, the most remembered are those related to: drug use or addictions (22), drinking and driving (20), speeding (18), mistreatment or child abuse (11); only 5 subjects have identified treatment or help for addictions. And one subject recalls the donation request to help children, which is the target of the child abuse ad.

Ads that are most exciting and pleasing. In general, none of the ads have been pleasing to the subjects. The most exciting ads are:

- “Other people make mistakes”. 15 subjects have considered it the most emotional.
- “No Brainer”. It has been considered the most emotional by 9 subjects.

It is striking that the most rational (health worker talking to the camera and posters with text) is at the same level as the video on child abuse (3 mentions in each case).

On the other hand, the percentage of subjects who did not feel particularly moved by these ads was high, with 11 of them answering "none" to this question.

Emotion perceived by the subjects. A scale was used to measure the emotional and subjective meaning that the different stimuli provoked in the subjects. The subjects were asked if they felt a specific emotion (sadness, anger, surprise, and disgust), having to indicate it on a scale with values ranging from 1 (they did not feel that emotion at all) to 5 (they felt that emotion very much). They were then asked to identify which ad or image provoked this emotion in them.

Sadness. 26 of the 41 subjects indicated that some of the ads had provoked a lot or quite a lot of sadness (5 and 4 on the scale). 14 subjects responded a little or some sadness (values 3 and 2). Only one subject stated that he did not feel sad about any of the messages.

As for the ad or images with which they associate this emotion: 26 subjects indicated that the ad that the experts identified as representative of sadness was the one that had caused them this emotion ("Other people..."), far above any other message: "Break the Cycle" (11), "Reconstruction" (6), "No Brainer" (4), and "Friends" (4). Two subjects found the rational ad in which, almost entirely, a doctor is talking to the camera ("Every hour") sad.

Anger. About half of the subjects (20) said that they had felt a lot or quite a lot of anger, 12 considered that they had felt a little or some anger, and 9 considered that no message had made them feel this emotion.

More than half of the subjects (25) emphasize that the ad they most relate to anger is the one about child abuse ("Break the Cycle"), the same as the one selected by the experts. 9 of the subjects consider that no ad has made them feel this emotion (the same number that placed 1 on the scale on this emotion). Of the remaining videos, the number of subjects who chose each of them is: "Reconstruction" (4), "No Brainer" (3), "Other people..." (3), "Friends" (1), and "Every hour" (1).

Surprise. 26 subjects were quite or very surprised by some of the ads viewed, 12 were a little or slightly surprised, and only 3 subjects answered that they did not feel this emotion.

Specifically, the ad with the gunshots in the car ("Friends") is the most surprising for 27 participants, with some quite significant comments: "In fact, I was so surprised that I didn't even notice the message itself". "No Brainer", where a man snorts his own brain, has surprised 14 subjects. "Reconstruction" (3) has been the third, "Other people..." (1) the fourth, while no participant has considered "Break the Cycle" or "Every hour" to have made them feel surprised. Two subjects were not surprised by any of the videos.

Disgust. The level of disgust among the subjects was: 25 felt a lot or quite a lot of disgust, 14 chose a little or some, and 2 subjects did not feel disgusted with these messages.

Regarding this emotion, the responses about which ad provoked the most disgust were almost unanimous (39 subjects): the message in which a person snorts his own brain. The other two participants answered that none of them were disgusting.

Most significant sequences/images. Several images are frequently repeated in the subjects' answers: images that appear in the ad in which time stops when two cars are about to collide (19 subjects), the one of the man who snorts his own brain (16), child abuse (16), the shot in the car (14), hit-and-run (7, one stands out that specifies: head on the ground), and doctor with real cases (1).

In some cases, they do not focus on a sequence or an image but on some generic element: parties (in the brain ad and the one with the gunshot) or car accidents (the one with the hit-and-run and the one with the car that runs a stop sign).

Suggested recollection of themes in the ads. The recollection of the themes is quite close to the reality of the messages used in the experiment. Speeding, the central theme of two ads, is recalled by all 41 subjects who participated in the research; cocaine consumption is recalled by 40 subjects (1 spot), along with drug and alcohol consumption, which is recalled by all 41 participants (the central theme of the "No Brainer" spot -cocaine consumption- and of "Friends" -shooting in the car-, although, in the latter case, it is alcohol consumption and driving). Another theme present in a spot is alcohol and driving, which is recalled by 37 subjects (central in a spot). And absent-mindedness on the road (34), the central theme of another spot.

The ad of the association against child abuse appears in several topics that have been remembered by the subjects: bullying (12), child abuse (12), and child mistreatment (31).

The totally informative ad, without any sequence especially valued in the spontaneous recall, appears in 35 of the responses since it is the spot that focused on the treatment of addictions.

Two responses must have been related to the spot on child abuse since some scenes can be interpreted in this way: sexism (18) and gender violence (21), probably because of the speed of the images in which a man is seen beating a girl at home; although from the association, we can deduce that it is the girl's father who, in the ad, can give rise to misunderstandings.

The rest of the proposals, which really are topics that are not in these ads, have had between 0 and 2 (Mobbing) responses, which shows that the topics of the spots have been captured.

Suggested recall of situations. In this item, different situations were suggested and the subjects had to indicate whether or not they remembered having seen them in the six ads and to associate each scene with a theme related to the previously seen ads. In general, they remembered the situations that were in the videos and correctly associated them with the themes of the ads. There are only two situations that do not appear in the videos and there is a high percentage of subjects who claim to have seen them: "A man hitting a woman while arguing" and "A young girl stealing in a store". A father is hitting a girl while having breakfast without any argument and a sequence where, from the window of a store, we see a young girl assaulting another person. There is also a situation that is in the ads that very few subjects remember: "A girl pricking herself to inject drugs". These three situations are in the same ad ("Break the Cycle") and their central theme is child abuse.

5. Discussion and Conclusions

In this research, when analyzing the data on the recall of ads according to the emotion conveyed and perceived by the subjects, the most recalled themes belong to the messages associated with disgust ("No Brainer") and surprise ("Friends"); and this recall is independent of whether the EI and AWI are positive or negative. While the data related to surprise may be predictable, the results for the ad associated with disgust are surprising; however, the strength and impact of a person cracking open

their brain to snort it like cocaine can become a difficult image to forget, highlighting the importance of considering other aspects of the narrative besides conveying an emotion.

When analyzing the data on parts of the ads that subjects consider less significant, it is observed that these correspond to those of the two ads considered rational.

From these results, it is possible to affirm that a relationship has been identified between the emotions generated in the viewers by the ads and the recall of the messages. Those with higher emotional activity were more remembered in the questionnaires carried out, both spontaneously and induced. This finding, which is consistent with previous research (Baraybar et al. 2017), highlights the importance of drawing on emotions to produce more effective advertising messages.

Although the two most remembered ads are emotional, the results obtained show that the difference between rational and emotional messages is not decisive for recollection since one of those categorized as rational ("Reconstruction") achieves a high degree of recall, both spontaneous and suggested; however, the rational ad that simply shows people talking to camera ("Every hour"), in which no story is told, shows the lowest levels of spontaneous recall of the six ads analyzed. One of the arguments that may explain its good results is the elaboration of a story supported by an attractive audiovisual production capable of obtaining a high recall rate. Consequently, what is important is the construction of an effective story, whether rational or emotional, and the correct application of formal resources to encourage curiosity and surprise.

Both the EI and AWI data show differences in the results obtained in the group formed by women compared to those obtained in the group of men.

The results of the two indexes show the importance of adapting, as far as possible, the messages to the different segments of the population since the emotional reaction varies according to the specific characteristics of each group of subjects to whom the campaigns are directed.

Another noteworthy conclusion is that no relevant differences have been observed, both in the EI and AWI, between rational and emotional messages.

Given this situation, it can be said that simply conveying emotions does not guarantee the effectiveness of an advertising campaign; how those emotions are conveyed is also very relevant. We have already mentioned the importance of building a good story, taking care of audiovisual production, or properly applying formal resources to improve the effectiveness of ads. This statement is even more interesting when we observe that the variations recorded in the indexes usually coincide with striking images, sound effects, and audiovisual editing resources. This allows us to confirm and influence the capacity of audiovisual language to generate emotional states in audiences and its strength in comparison with the narratives inherent in other advertising media. Regarding sound aspects, its enormous primary emotional impact has been evidenced. Among other reasons, in coincidence with the reflections of Francis Wolff, is because they do not evoke things but events, and that evocation causes us automatic reactions that trigger neurotransmitters and create very intense emotions (Wolff, 2015).

It is also observed, analyzing the recall test data, a quite generalized coincidence between the emotion perceived by the subjects in each of the ads with the one that, in the opinion of the experts, is representative of that ad. These results are in line with those obtained by Baraybar et al. (2017) in a research work with a sample of ads from different institutions and commercial brands.

Concerning memory, it should be noted that the sign, positive or negative, of the values obtained, both for the EI and the AWI, does not influence this variable. In the case of the EI, the average index, for the group composed of women and for the group formed by men, is negative in all the ads, and themes and situations are remembered in most of the messages. Something similar happens in the case of AWI since, although it has positive averages for some ads, in women and men, situations are remembered with both positive and negative AWI.

Most of the selected spots have reached high levels of emotion and recall. Consequently, they seem to be successful as communications aimed at the prevention of audiences exposed to these situations but their effectiveness has not been measured for those with habitual behaviors or pathologies related to the behaviors they are trying to modify, such as drug addicts or drivers who consume alcohol. This situation allows us to raise new hypotheses and opens new lines for future research according to the target audience of the campaign, the choice of the stories, and the protagonists of the stories.

Finally, we can conclude, in line with what Shen and Morris (2016) pointed out, that research on the effects of advertising communication improves with the integration of conventional models and techniques and those of neuroscience. Thanks to the latter, in the face of the difficulty to verbalize or recognize the emotions perceived or felt by the subjects, it has been possible to record their emotional responses, positive or negative, during the viewing of ads, making it possible to relate these variations to the sensory stimuli received.

Despite its limitations, the use of the questionnaire provides knowledge of the effectiveness of the messages in terms of the recall suggested and recognized by the participants. This complementarity makes it possible to envision an applied development of this type of research beyond the academic field (Baños-González et al., 2020).

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AUTHOR/S:

Antonio Baraybar Fernández

Universidad Rey Juan Carlos. Spain.

He holds a Ph.D. in Information Sciences from the Universidad Complutense de Madrid. Professor of Audiovisual Communication and Advertising at the Universidad Rey Juan Carlos. His research and teaching interests are related to the economics of communication, specifically with marketing, communication management in organizations, new emerging business models brought about by new technologies, and neuro-communication. Member of the INFOCENT research group of the Universidad Rey Juan Carlos, recognized for its high performance. He has several dozens of scientific-academic publications and extensive experience in various research projects, funded by public calls, nationally and internationally.

antonio.baraybar@urjc.es

Índice H: 9 **i10:** 9

Orcid ID: <https://orcid.org/0000-0002-5474-5214>

ResearchGate: <https://www.researchgate.net/profile/Antonio-Fernandez-37>

Miguel Baños González

Universidad Rey Juan Carlos. Spain.

He holds a Ph.D. in Information Sciences from the Universidad Complutense. Professor of Audiovisual Communication and Advertising at the Universidad Rey Juan Carlos. He has extensive teaching and research experience, having participated in various research projects, funded by public calls, nationally and internationally. His lines of research focus on new technologies, marketing communications, and advertising creativity. Author of several books, book chapters, and scientific articles always in the field of communication and new technologies. He has also published several articles in professional communication journals and has developed extensive professional activity, from 1985 to 2004, in different national and international advertising agencies.

miguel.banos@urjc.es

Índice H: 20

Orcid ID: <https://orcid.org/0000-0002-0195-2754>

Scopus ID: <https://www.scopus.com/authid/detail.uri?authorId=56003904800>

Google Scholar: <https://scholar.google.com/citations?user=NpkIlsUAAAAJ&hl=en>

ResearchGate: <https://www.researchgate.net/profile/Miguel-Banos-Gonzalez>

Dialnet: <https://dialnet.unirioja.es/servlet/autor?codigo=2995455>

Mario Rajas Fernández

Universidad Rey Juan Carlos. Spain.

He holds a Ph.D. in Audiovisual Communication from the Universidad Complutense de Madrid. Professor of Audiovisual Communication and Advertising at the Universidad Rey Juan Carlos.

Director of the FlixOlé-URJC Research Chair in Spanish Cinema (<http://cinespanol.es>). Coordinator of the Consolidated Research Group Ciberimaginario of the URJC (<http://ciberimaginario.es>).

He has published several scientific articles and monographs and has been recognized by the CNEAI for two six-year research periods and one six-year transfer period. He has participated in national (2 as Main Researcher) and international competitive research projects. He has carried out research stays in centers such as the Instituto Tecnológico de Monterrey (Mexico), the University of California Los Angeles (USA), the Escuela Internacional de Cine y Televisión de San Antonio de los Baños (Cuba) and the Universidade Católica Portuguesa, and has participated in more than 60 academic activities such as congresses and international conferences.

mario.rajas@urjc.es

Índice H: 13 **i10:** 18

Orcid ID: <https://orcid.org/0000-0002-3807-8327>

Scopus ID: <https://www.scopus.com/authid/detail.uri?authorId=57190391084>

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