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**INVESTIGACIÓN/RESEARCH**

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# TELEVISION-APPLIED NEUROSCIENCE: MEASURING ATTENTION AND EMOTION IN THE SERIES "FOREVER"

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## ABSTRACT

In this paper we show the results of an experiment on the first chapter of the American series entitled "Forever", in which the electrodermal activity of a group of 30 people was simultaneously measured using the technology Sociograph. After the broadcast, a self-administered survey among participants in the experiment was carried out. The results show Increases in EDL preceded by a sudden change in sound or visual situation and unpredictability linked to situations that generate anticipation for the uncertain outcome. The decreases occur in situations of quietness and calmness, with a predictable solution that could generate boredom in the audience. The most important sudden changes in the phasic activity (EDR) are given in relation to violent content, conversations between main characters with high emotional charge, and finally in situations with high expectation. Remarkable is the presence of music at all times. In the subsequent survey conducted at the end of the broadcast, the main characters got high overall ratings, which, together with the fact that they are involved in all sequences with Increased EDL and EDR, suggest that they maintained a positive attentional and emotional relationship with the audience, which is an Important key to the success of the series. Certainly, this fact is reinforced by the high overall rating of the series, as well as the intention to continue watching it in the future.

## KEY WORDS
Neuroscience - TV - series - attention - emotion – audience

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# NEUROCIENCIA APLICADA A LA TELEVISIÓN: MEDICIÓN DE LA ATENCIÓN Y LA EMOCIÓN DE LA SERIE "FOREVER"

**RESUMEN**

En este trabajo se muestran los resultados de un experimento de neurociencia sobre el primer capítulo de la serie americana Forever, en el que se midió simultáneamente la actividad electrodérmica de un grupo de 30 personas usando la tecnología Sociograph. Tras la emisión, se realizó una encuesta de tipo auto administrado entre los participantes en el experimento. Los resultados ponen de manifiesto incrementos de EDL van precedidos de un cambio de situación sonora o visual brusca, y ligados a situaciones que imprevisibilidad que generan expectación por lo incierto del desenlace. Los decrementos se producen en situaciones de tranquilidad y calma, de solución previsible, que podrían generar tedio en la audiencia. Los cambios más importantes, de tipo súbito, en la actividad fásica (EDR) se dan en relación a contenidos violentos, en conversaciones entre los protagonistas con alta carga emotiva, y en situaciones con alta expectación. Es destacable la presencia de música en todos estos momentos. En la encuesta posterior realizada al final de la emisión, los protagonistas obtienen valoraciones generales altas, lo que unido a que participan en todas las secuencias con EDL y EDR incrementadas, hace sugerir que logran mantener durante la emisión del capítulo una relación atencional y emocional positiva con los espectadores, elemento clave sin duda para el éxito de la serie. Este hecho viene sin duda reforzado por una valoración general de la serie alta, así como de la intención de seguir viéndola en el futuro.

**PALABRAS CLAVE**
Neurociencia – televisión – serie – atención – emoción – audiencia

## 1. INTRODUCTION

Today, episodically storytelling is in a moment of hatching. Many TV channels devote large budgets to the generation and marketing of these narrative formats, which in many cases means high-risk activity because of its high cost and the uncertainty of the return on this investment.
It is therefore important to develop methods that reduce this uncertainty, which necessarily involve studying the preferences of the audience.
However, in many cases the opinion polls are not able to adequately respond to the issues required with the necessary precision, since many of the mental processes that determine the success of these formats are non verbalizable, since the audience is often unaware of them.
Therefore, the psychobiological study of the audience takes special relevance in this context. Currently, the most commonly used methods are positron emission

tomography, functional magnetic resonance imaging, electroencephalogram, magnetoencephalography and the electrodermal activity (Touhami et al, 2011: 1528).
The so-called electrodermal activity is by its sensitivity, reliability and ease of measurement, one of the most used means to measure attention and emotion, so it is used in this paper, but with a twist: it is measured simultaneously with a group people using a technology called Sociograph, the viability of which has previously been tested by Martinez Herrador (2012, 2008) and Aiger, M. et al. (2013).
The importance of these studies is increasing (Morin, 2011; Blakeslee, 2004; Boricean, 2009), also in Spain (Andreu-Sanchez et al, 2014.), Although more frequently applied to the field of marketing and advertising (Gil-Lafuente et al, 2010; Avendaño Castro, 2013; Reimann, 2012; Vecchiato et al, 2014. Sanchez-Porras, 2013).
It is, in short, a psychobiological phenomenon discovered by Fere in 1881. The psychobiological mechanisms involve changes in the bioelectric properties of the skin due to modifications in their plasma structures and in the activity of the sweat glands innervated by the sympathetic nervous system, which is responsible for the activation processes.
Electrodermal activity (EDA) is widely used in social science research, for its high capacity to respond to new, affective, and cognitive threatening stimuli and situations of anxiety and stress (Beer, 2007). It can be classified into tonic activity (EDL), related to attentional processes, phasic activity (EDR), which indicates mental processes related to emotion, and finally spontaneous activity (NSA), nonspecific and specific to each subject, which should be considered noise and be ignored.
This article shows the results of an experiment in neuroscience applied to the first chapter of the television series Forever. The series, of American nationality, was created by Matt Miller. The first episode, entitled Pilot, directed by Brad Anderson, premiered on September 22, 2014 on the television network ABC (American Broadcasting Company) and had an audience of 8.25 million viewers.
The plot revolves around a New York medical examiner, Dr. Henry Morgan, immortal, who studies the murders that take place in the city in an attempt to discover the reason of his own immortality.
After his first death in a ship 200 years ago, the protagonist appears naked in the water of the New York coast every time he dies, a fact known only to dealer Abe, whom Morgan and his wife Abigail, who leaves his life somewhere between 1960 and the present, found newborn in a German concentration camp during World War II.
However, Dr. Morgan is chased by a murderer, named Adam, who also discovered this fact and states he also have this condition of immortality but has lived 2,000 years.
Because he does not age, Dr. Morgan has developed an extraordinary talent for observation that impresses those who know, and that includes the attractive detective of New York Police Department, Jo Martinez, with whom he forms a successful researching tandem.
The main actors are Ioan Gruffudd starring as Dr. Henry Morgan, Alana de la Garza as Jo Martinez, Lorraine Toussaint as Lieutenant Joanna Reece, Donnie Keshawarz as Lieutenant Hanson, Joel David Moore as Lucas Wahl, Judd Hirsch as Abe, MacKenzie Mauzy as Abigail and Burn Gorman as Adam.

## 2. OBJECTIVES

The proposed objectives for this experiment are:

1) Objective measurement of attention (EDL) of a sample population during the broadcast of the first episode of the series "Forever" by examining their electrodermal activity.
2) Objective measurement of emotion (EDR) of a sample population during the broadcast of the first episode of the series "Forever" by examining their electrodermal activity.
3) Establishment of relationships between what is objectively measured and what is consciously indicated (and therefore subjectively evaluated) by a self-administered questionnaire for viewers.

## 3. METHODOLOGY

A series not broadcasted in Spain, Forever, was chosen to eliminate biases attributed to prior knowledge and familiarity of the audience with it.
The sample chosen by the convenience sampling method consists of 30 people aged from 20 to 30 years old of both sexes (in similar proportions). Therefore, it is a sample whose results should be considered exploratory.
For the development of this piece of research, a mixed methodology that included, on one hand, the objective record of the level of attention and emotion of the sample by analyzing their electrodermal activity and, on the other hand, other opinions regarding the broadcasted chapter, developed by using a self-administered questionnaire.
Two passes of 15 people were made on February 26, 2015 in the hall of degrees of Miguel de Cervantes European University in Valladolid. At the entrance of the enclosure, we placed a bracelet to participants, which bracelet sent information of each person to a central processing unit responsible for calculations and storage.
The measuring device analyzes the electrodermal activity in three types of signals:

1) Tonic activity related to attention (EDL, or electrodermal level). The unit of measurement used is the sum of electrodermal resistance in Kilomnios (K□) of all participants. It is important to note that the lower the resistance, the higher the level of attention.
2) Phasic activity related to emotion (EDR, or electrodermal response). In this case, the unit of measure is the arithmetic mean of electrodermal resistance in Kilomnios (K□) of all participants. In this case, the higher the average, the greater the intensity of emotion. We must note that the machine simply detects the presence of emotion, but not the type or content thereof; it therefore dos not discriminate between positive and negative emotions.
3) A spontaneous, non-specific, random and independent signal from each person (NSA, or nonspecific activity). The unit of measurement used is electrodermal resistance in Kilomnios (K□). Being nonspecific and subjective, this signal should be considered noise, so it was offset by the global arithmetic mean to subsequently discriminate and disregard it.

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This technology is named Sociograph, Patent No. 9902767, and it has been used in previous cases such as Farrier Martinez, J.L. et al. (2008, 2012) and Aiger, M. et al. (2013).
Subsequently, following the broadcast of the chapter, participants were asked to fill in a self-administered questionnaire.
For the analysis of the collected data, statistical techniques adapted to the characteristics of the obtained time series were used, using models for longitudinal studies.

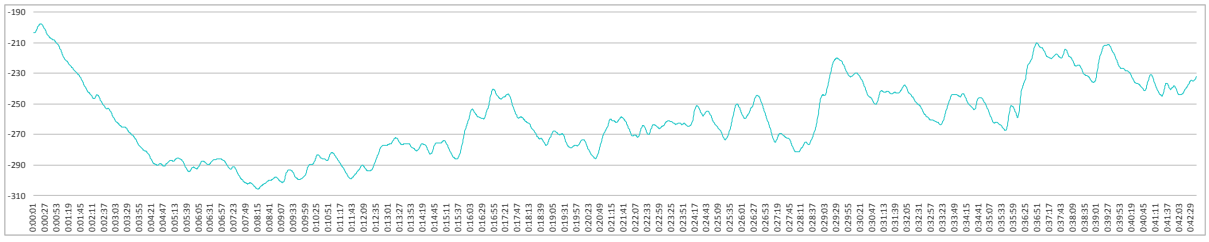
## 4. RESULTS

It should be noted first that the experiment was conducted in response to a time series model with strong autocorrelation, reflecting the impact of previous levels of attention and emotion on the subsequent ones.

### 4.1. ATTENTION

The average level of attention obtained for the series is 260.0532 K□, with a standard deviation of 24.5635 K□ minimum 197.76488 and maximum 305.80550 K□.. Kurtosis coefficients (-0.681) and asymmetry (-0.285) obtained indicate, in relation to attention at different times of the broadcast of the series, a distribution with slight asymmetry to the right. However, in a broad sense, we can say that the level of attention of the broadcasted chapter fits normal distribution.
Before presenting the results in detail, it should be noted that the standard of attention is measured in terms of resistance, so that the lower the resistance, the higher level of attention, and vice versa.
The analysis of the curve of attention is based on the estimation of exchange rates of the tonic level (EDL). An increase in the EDL level implies increased attention and a decrease a decline. Therefore, the most important feature of the series is the increase or decrease that occurs throughout the session.
The broadcasted chapter maintains a growing general structure, after a sharp decline at the beginning of it. Indeed, a strong decrease of attention is observed during the first four minutes, which then stabilizes and grows more or less abruptly at times, as can be seen in Figure 1.

**Figure 1: EDL (electrodermal level) of Chapter 1, Series Forever (K□)**



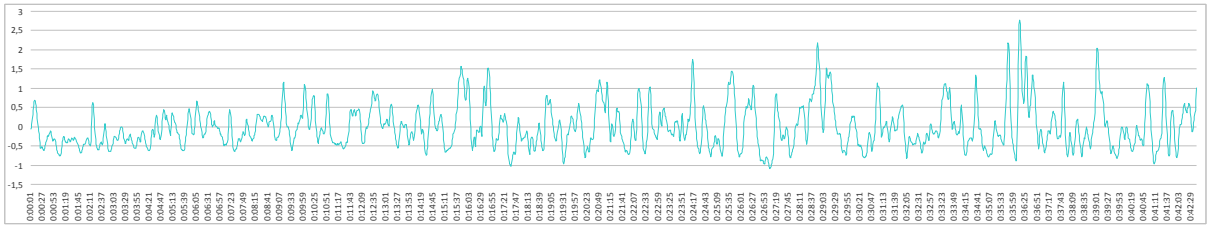

**Source**: Made by myself

Thus, there can be seen certain sections where attention undergoes substantial variations. These sections relate to sequences that run from minutes 00:27 to 4:03,

15:40 to 15:55, 20:40 to 20:55, 28:40 to 28:55, 29:06 to 29: 21, 36:23 to 36:45 and 38:59 to 39:09.

These sequences can also be seen clearly in Figure 2.

**Figure 2: Rate of absolute change EDL (K□). Chapter 1, series Forever.**



**Source:** Made by myself

The content of each of these moments is summarized in the following table.

**Table 1. Description of the sequences and EDL Rate Variation (K□)**

| Sequence | Variation Rate EDL (K□) | Description |
|---|---|---|
| 00:27 to 4:03 | -78.9395 | The protagonist, Henry Morgan, takes the subway, where he has a talk with a blonde girl. The metro has an accident (2:10). A voiceover (2:26) presents the protagonist and the situation that motivates the series. |
| 15:39 to 16:03 | 29.10431 | Henry Morgan starts to talk to Abe, a friend. Jazz music precedes the talk. |
| 20:42 to 20:55 | 14.13392 | Abe injects a substance to Henry Morgan. |
| 28:37 to 28:55 | 26.12317 | Two policemen speak at a crime scene on matches with another crime. Henry Morgan looks at a photography and music sounds. He starts to talk to Jo Martinez (a policewoman). |
| 29:06 to 29:21 | 20.27554 | Henry Morgan and Jo Martinez continue their previously started talk. |
| 36:23 to 36:45 | 23.70291 | Henry Morgan falls from the roof of a building on a taxi on the street. He looked like died Henry in midplane. He revives, and Jo Martinez is seen waking up in a hospital bed, where the first thing you see is the figure of Henry. |
| 38:59 to 39:09 | 16.63376 | Henry, before leaving the hospital, |

| | | |
|---|---|---|
| | | has a highly emotional talk with Jo Martinez, who is still in bed. |

* A positive value in the rate of change involves an increase in EDL in the analyzed stretch and vice versa.
**Source:** Made by myself

The decrease in EDL occurs during an initial common situation of predictable solution, such as the conversation at the subway between the protagonist and a woman. The presentation of the situation is not particularly emotional, neither is it is accompanied by large visual or sound changes. The voiceover of the protagonist Henry Morgan is at this point familiar to the audience.
Therefore, we can consider that, in short, the situation of decline follows a smooth, predictable chapter start.
The increases in EDL are preceded by a sudden visual or sound change of situation. The development of these sequences is linked in all cases to a situation of unpredictability, so it is possible to suggest that the expectation of the uncertainty of what will happen generates this increased attention.

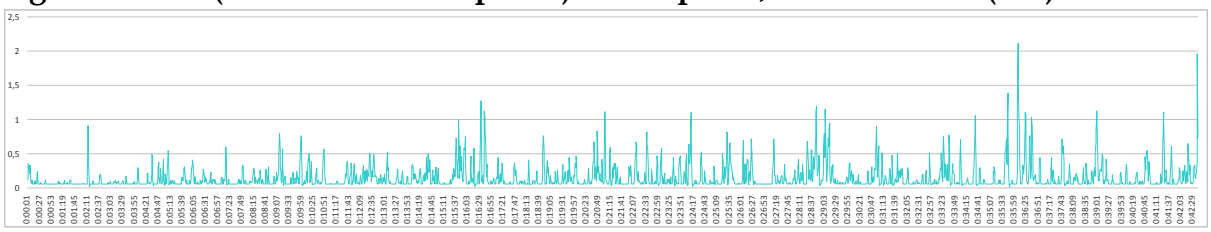
### 4.2 EMOTION

The average level of emotion obtained by the series is 0.15243 K□, with a standard deviation of 0.18095 K□, a minimum of 0.1138 and a maximum of 2.1166 K□. The Kurtosis coefficients (18.2907) and asymmetry (3.5159) obtained indicate, in relation to the average emotion at different times of the broadcast of the series, a leptokurtic distribution with asymmetry to the left (given by a low average value with momentary very high peaks).

The analysis of EDR levels in the subsequent series shows sudden changes in skin resistivity relating to the reactions to specific stimuli. Those areas where the extent of the changes is big point to greater emotional activity, while those sequences with low magnitude EDR values are considered unexciting.

Below is a graph of the EDR levels obtained during the broadcast.

**Figure 3: EDR (electrodermal response) of Chapter 1, series Forever (K□)**




**Source:** Made by myself

So emotionally charged moments are seen in 02:14, 15:44, 16:32, 21:04, 24:12, 28:46, 29:06, 34:33, 35:45, 36:07, 36:23, 36:37, 39:00, 41:25 and 42:39.

The following table shows the content of these moments.

**Table 2. Description of the situation and obtained EDR (K□)**

| Min / Sec | EDR (K□) | Situation |
|---|---|---|
| 2:14 | 0.90475 | A subway coach crashes into a station. |
| 15:44 | 1.001875 | Henry Morgan tells Abe, "don't delight". Jazz music plays in the background. |
| 16:32 | 1.267875 | Henry Morgan opens an envelope while raising the volume of the background music. |
| 21:04 | 1.113 | Henry Morgan, lying, waits for the deadly reaction to the injection, which comes three seconds later. Suspense background music is played. |
| 24:12 | 1.099 | In an interview with Jo Martinez, Henry Morgan says he agrees with the thesis of Jo. Background music is played. |
| 28:46 | 1.196125 | Henry Morgan looks at a picture. Background music is played. |
| 29:06 | 1.143625 | Jo Martinez tells Henry Morgan that "therefore not be surprised. People kill for worse reasons than revenge". Background music persists. |
| 34:33 | 1,057 | Close-up of Henry Morgan after a shot to Jo Martinez. Suspense background music is played. |
| 35:45 | 1.386875 | Henry Morgan is shot. Suspense background music sounds is played. |
| 36:07 | 2.116625 | Henry Morgan is dying on the floor. Suspense background music continues. |
| 36:23 | 1.101625 | Midplane of Henry Morgan dead on a yellow car. Car alarm sounds and suspense background music. |
| 36:37 | 1.031625 | Close-up of the eyes of Jo Martinez. The beeps of a medical device can be heard. |
| 38:59 | 1.12875 | Jo Martinez, in bed, asks Henry Morgan "Henry, is everything all right?" No background music. |
| 41:25 | 1.10775 | Jo Martinez tells Henry Morgan at his store, "Hello!, was in the neighborhood." Background music is played. |
| 42:39 | 1.953875 | After a molten negreo, the credits of the series appear and a musical piece begins. |

**Source:** Made by myself

We must note that 7 out of the 15 most intense moments of EDR occur in sections with increased EDL. Examining the intensity EDR peaks, it is clear that, out of the 10 most intensive times, only 3 (positions 5, 7 and 10) occur in sections with increased EDL, which ultimately reveals no relationship between EDL and EDR.
Music is present in 14 out of the 15 times with increased EDR - the other has a very strong visual content, an very violent subway accident-, which allows us to suggest the importance of the use of music in intense emotional moments.
Moreover, it is also noteworthy that in the 5 most intense EDR times there is no voice, only image and instrumental sound that enhances the visual content.
With regard to content, the records of more intense EDR occur in three types of situations:

1) Unusual situations with violent content (6 of them) and music that aims to enhance the visual content.
2) Emotionally charged situations with the protagonist and Jo Martinez, with background music (5 of them).
3) Previous moments to the end of the sequence, also with background music (in addition, the remaining 4), which may suggest the existence of a pattern of increased attention by expectation for the end of said sequence.

Therefore, it can be seen that the most intense emotional reactions take place at the time of an accident or violent act, or when the lead character starts to emotionally talk to Jo Martinez and background music is played, or at moments of expectation when background music is played too.

### 4.3 OPINION POLL

The survey conducted at the end of the broadcast of the chapter serves to underscore several important events.
The overall assessment of the chapter is quite good (7.35 on average), somewhat better in the case of women, but with greater disparity of opinion in this regard among this group (the standard deviation was twice in the case of women ), although this difference is not statistically significant (Coeff. Sig. 0.246 in T test).
Similarly, no significant differences were found as to whether viewers are regular followers of series -which was evaluated on a scale of 4 positions- (Coeff. Sig. 0.936 in ANOVA test) or the frequency of use of television -which it is also evaluated on a scale of 4 positions- (Coeff Sig 0.808 in ANOVA test).
Moreover, the declared intention to continue viewing the series is lower (6.27 on average), slightly higher also in the case of women, although the disparity of opinion is very high (standard deviation of 2.803), similar in both sexes. As in the previous case, this difference between genders is not significant (Coeff. Sig. 0.227 in t-test).
As in the previous case, no significant differences were found as to whether viewers are regular followers of series (Coeff. Sig. 0.890 in ANOVA test) or the frequency of use of television (Coeff. Sig. 0.948 in the same test).
Finally, the valuation of the main characters of the series can be seen in the following table.

**Table 3.** Average Rating characters by sex (1-10 scale).

| Sex | | Henry Morgan | Jo Martínez | Abe | Hanson | Wahl |
|---|---|---|---|---|---|---|
| Man | Half | 7,42 | 7,08 | 6,67 | 3,50 | 4,92 |
| | Desv. típ. | 1,311 | ,996 | 1,723 | 1,314 | 1,443 |
| | kurtosis | ,307 | -,014 | ,521 | ,654 | ,019 |
| | Asymmetry | -,944 | -,854 | -,531 | ,000 | -,699 |
| Woman | Half | 8,44 | 7,75 | 7,61 | 4,44 | 6,78 |
| | Typical deviation | 1,542 | 1,593 | 2,004 | 1,822 | 1,700 |
| | Curtosis | ,038 | -1,101 | ,312 | 1,275 | -,133 |
| | Asymmetry | -,965 | -,491 | -,874 | ,428 | -,742 |
| Total | Half | 8,03 | 7,48 | 7,23 | 4,07 | 6,03 |
| | Typical deviation | 1,520 | 1,405 | 1,924 | 1,680 | 1,829 |
| | kurtosis | -,358 | -,859 | -,153 | 1,332 | -,533 |
| | Asymmetry | -,629 | -,223 | -,573 | ,542 | -,306 |

**Source:** Made by myself

The characters of Henry Morgan and Jo Martinez are the ones that best average rating obtained, followed by Abe and, far away. by Hanson and Wahl, whose low valuation could be due to their rare appearances in the series.
No significant differences were obtained by gender (COEFS. Sig. -Henry- 0.069, 0.208 and 0.193 Jo Martinez -Abe- on T tests performed) or as to whether viewers were regular followers of series (Coeff. Sig . -Henry- 0.148, 0.441 and 0.208 Jo Martinez -Abe- in ANOVA), and finally in relation to the frequency of use of television (Coeff. Sig. -Henry- 0.661, 0.217 and 0.261 Jo Martinez -Abe- in ANOVA tests).
The mean assessments are relevant, as the highest moments with EDR are mostly starred (14 seconds out of 15) by the two most valued characters, and the remaining by Abe.
The high assessment, combined with objective measurement generated by the protagonists in higher emotional moments, makes us suggest the idea that these characters have failed to establish a positive emotional connection with viewers.
Regarding attention -EDL-, the same trend should be noted: all sequences that have generated more attention are starred by Henry Morgan and Jo Martinez, and Abe appears in one of them.
In conclusion, we must suggest a positive emotional and attentional overall assessment by the two protagonists who are able to maintain attention and generate positive emotional content in viewers.

## 5. DISCUSSION

The results shown on the series Forever show, in relation to the measurement of attention -EDL-, an increasing overall structure, following a sharp decline in attention during the first four minutes.

This situation of decreased EDL follows a smooth, predictable chapter start, which could lead to boredom and consequently reduce attention. In contrast, increases in EDL are preceded by a sudden visual or sound change of situation. The development of these sequences is linked in all cases to a situation of unpredictability, so it is possible to suggest that the expectation of the uncertainty of what will happen generates increases in attention.

Measuring the generated emotion -EDR-, this being understood by the mere presence, not its content, does not show a clear relationship with sections of increased EDL.

With regard to content, the more intense EDR increases occur at the time of an accident or violent act, when the protagonist of the series (Henry Morgan) starts to emotionally talk to Jo-laden Martínez (the other protagonist) and background music is played, or at moments of expectation where background music is played too.

It is also noteworthy that the protagonists (Henry Morgan and Jo Martinez) obtain high overall ratings, which, together with the fact that they are involved in all sequences with increased EDL and EDR, does suggest that they manage to maintain a positive attentional and emotional relationship with viewers during the broadcast of the chapter, certainly a key element to the success of the series.

This fact is certainly reinforced by a general high assessment of the series, as well as the intention to continue seeing it in the future.

In these assessments, no significant differences were found in gender or in relation to the frequency of use of television or the intensity to follow the series.

The most important limitation of this study lies in the composition of the sample, 30 people and fixed according to the convenience of researchers (although stratified in relation to sex, frequency of use of TV and intensity to follow the series), which confers this paper an exploratory nature.

Future research could delve into the details of the emotional content, establishing nuances of personality of the characters, which could help optimize the story or the content of important sequences, or possibly improve the commercial exploitation of characters in the form of merchandising, advertising, sponsorships or other forms of marketing.

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