ICONO 14

ICONO 14, Revista de comunicación y tecnologías emergentes, 20(2), 2022. ISSN: 1697-8293
https://doi.org/10.7195/ri14.v20i2.1853

Monográficos

Neuroscience and communication in health: Proposed analysis of the orienting and defence responses to gain and loss messages in vaccination campaigns

La neurociencia de la comunicación en salud: Propuesta de análisis de las respuestas de orientación y defensa frente a mensajes de ganancia y pérdida en campañas de vacunación

A comunicação neurocientífica da saúde: Uma proposta para a análise das respostas de orientação e defesa às mensagens de vitória e de perda nas campanhas de vacinação

Ubaldo Cuesta Cambra[1]*
José Ignacio Niño González[1]**
Carolina Bengochea-González[1]***
Marion Roberts Martínez[1]****

[1] Department of Communication Theories and Analysis. Universidad Complutense de Madrid, Spain

* Professor of the Department of Communication Theories and Analysis. Universidad Complutense de Madrid, Spain
** Associate Professor of the Department of Communication Theories and Analysis. Universidad Complutense de Madrid, Spain
*** Assistant Professor of the Department of Communication Theories and Analysis. Universidad Complutense de Madrid, Spain
**** Research Assistant at the Department of Communication Theories and Analysis. Universidad Complutense de Madrid, Spain

Received: 10/02/2022; Revised: 19/02/2022; Accepted: 26/05/2022; Published: 03/08/2022

Translation to English: STAR Servicios Lingüísticos S.L.

To cite this article: Cuesta Cambra, Ubaldo; Niño González, José Ignacio; Bengoechea-González, Carolina; & Roberts Martínez, Marion. (2022). Neuroscience and communication in health: Proposed analysis of the orienting and defence responses to gain and loss messages in vaccination campaigns. *ICONO 14. Scientific Journal of Communication and Emerging Technologies* 20(2).https://doi.org/10.7195/ri14.v20i2.1853

Abstract

The idea that vaccines are not safe is spreading more and more through “anti-vaccine” movements. It is necessary to develop communication campaigns that counteract the effects of these anti-vaccine messages, investigating the underlying psychosocial mechanisms and for this, this research proposes a very novel hypothesis: the psychophysiological responses that a campaign of this type provokes can be assimilated to the pattern of orientation responses (RD) and defense (RD) proposed by Pavlov (1910): alteration of brain waves, modification of dermoelectric response, heart rate, micro-expressions (muscular), focal attention eye movements, etc. These responses act as a “pattern”: they respond jointly and in a similar direction. If this hypothesis is correct, threatening messages will generate RD while non-threatening messages will generate RO. A pilot experiment is carried out using a factorial design of independent measures, where the main factor is "type of message framing" (loss vs. gain) and the dependent variables are the "psychophysiological records of the OR/RD" (Electroencephalogram (EEG), Galvanic Skin Response (GSR), Eye Tracking and Muscular Facial Expression). The results allow us to validate the hypothesis: gain messages cause RO and loss messages cause RD. These results are very relevant for the implementation of health communication campaigns: vaccination campaigns among the young population should be built from a profit frame, which will generate a much more effective RO pattern to achieve persuasion than the DR pattern.

Keywords: Neurocommunication; Gain-loss frame; Orientation response; Anti-vaccine – GSR; EEG; Facial Expression

Resumen

Cada vez se extiende más la idea de que las vacunas no son seguras a través de movimientos “antivacunas”. Es necesario desarrollar campañas de comunicación que contrarresten los efectos de estos mensajes antivacunas, investigando los mecanismos psicosociales subyacentes y para ello, esta investigación plantea una hipótesis muy novedosa: las respuestas psicofisiológicas que suscita una campaña de este tipo son asimilables al patrón de respuestas de orientación (RD) y defensa (RD) planteado por Pavlov (1910): alteración de ondas cerebrales, modificación de respuesta dermoeléctrica, de frecuencia cardíaca, micro-expresiones (musculares), movimientos oculares de atención focal, etc. Estas respuestas actúan como un “patrón”: responden de forma conjunta y en similar sentido. Si esta hipótesis es correcta, los mensajes amenazantes generarán RD mientras que los mensajes no-amenazantes generarán RO. Se realiza un experimento piloto mediante diseño factorial de medidas independientes, donde el factor principal es “tipo de encuadre del mensaje” (pérdida vs. ganancia) y las variables dependientes son los “registros psicofisiológicos

propios de la RO/RD" (Electroencefalograma (EEG), *Galvanic Skin Response* (GSR), *Eye Tracking* y *Muscular Facial Expression*). Los resultados permiten validar la hipótesis: los mensajes de ganancia provocan RO y los de pérdida provocan RD. Estos resultados son muy relevantes de cara a la implementación de campañas de comunicación en salud: las campañas de vacunación entre población joven, los deben ser construidas desde un *frame* de ganancia, el cual generará un patrón de RO mucho más eficaz para lograr persuasión que el patrón de RD.

Palabras clave: Neurocomunicación; Frame de ganancia y pérdida; Respuesta de orientación; Antivacunas –GSR; EEG; Expresión facial

Resumo

A ideia de que as vacinas não são seguras está se espalhando cada vez mais por meio de movimentos "anti-vacina". É necessário desenvolver campanhas de comunicação que contrariem os efeitos dessas mensagens antivacinas, investigando os mecanismos psicossociais subjacentes e, para isso, esta pesquisa propõe uma hipótese muito nova: as respostas psicofisiológicas que uma campanha desse tipo provoca podem ser assimiladas ao padrão de respostas de orientação (RD) e defesa (RD) proposto por Pavlov (1910): alteração das ondas cerebrais, modificação da resposta dermoelétrica, frequência cardíaca, microexpressões (musculares), movimentos oculares de atenção focal, etc. Essas respostas agem como um "padrão": elas respondem em conjunto e em uma direção semelhante. Se esta hipótese estiver correta, mensagens ameaçadoras irão gerar RD enquanto mensagens não ameaçadoras irão gerar RO.

Um experimento piloto é realizado usando um desenho fatorial de medidas independentes, onde o fator principal é "tipo de enquadramento da mensagem" (perda vs. ganho) e as variáveis dependentes são os "registros psicofisiológicos do OR/RD" (Eletroencefalograma (EEG), Resposta Galvânica da Pele (GSR), Rastreamento Ocular e Expressão Facial Muscular). Os resultados permitem validar a hipótese: mensagens de ganho causam RO e mensagens de perda causam RD. Esses resultados são muito relevantes para a implementação de campanhas de comunicação em saúde: as campanhas de vacinação entre a população jovem devem ser construídas a partir de um quadro de lucro, o que gerará um padrão de RO muito mais eficaz para alcançar a persuasão do que o padrão DR.

Palavras-chave: Neurocomunicação; Quadro ganho-perda; Resposta de orientação; Antivacina – GSR; EEG; Expressão Facial

Introduction

According to the World Health Organization (WHO), vaccinations are science's greatest contribution to countering diseases in the history of humanity (Castañeda *et al.,* 2021). Multiple studies have proven that their effectiveness and administration have contributed to eradicating diseases that have systematically decimated the population throughout history (Valenzuela, 2020). However, their unquestionable value is not perceived equally within advanced societies, in which certain opinion groups reject the scientific evidence and

focus their critiques on the possible negative side effects of vaccines, despite the WHO's repeated proof that guarantee their safety (Sánchez *et al*., 2020). In this regard, there is a major risk that the idea that vaccines are not safe could spread more widely around Europe and other Western regions. Despite the fact that the anti-vaxxer movement is not highly developed in Spain, where the healthcare system is very effective and efficient, Spain ranks tenth in Europe in the acceptance of vaccines, even though much of the Spanish population perceives them as insignificant, unsafe and ineffective (Larson *et al.*, 2014).

There is no question that the appearance of this 'anti-vaccination' phenomenon (Nasir, 2000; Zimmerman *et al.*, 2005) is a risk factor that is seriously threatening the global population and is particularly important in circumstances like those of today, when the health crisis caused by COVID-19 is focusing on vaccines as the prime measure to defeat this new disease (Olliaro, 2021). However, the presence of anti-vaccination movements in the media, supported by the ease with which disinformation and fake news can be spread on the social media (Fernández & Baquero, 2019; López, González & Hernández, 2020) pose a huge danger in a society in which public opinion can easily be manipulated (Piqueiras et al., 2020). In view of these denialist trends, health communication campaigns must be developed to counter the effects of these groups and disseminate contents that help discredit these false arguments and spread evidence based on indisputable scientific evidence (Martos, 2010). In short, communication campaigns have to be planned based on the empirical evidence provided by scientific research in order to generate messages constructed with variables that foster a change in attitudes and, in the long term, healthy behaviour (Cuesta *et al*., 2020).

Therefore, researching how communication actions in the field of health can be more effective is a top priority, so it is essential to define what types of messages are the most likely to generate a predisposition in favour of vaccines (Gallagher & Updegraff, 2012). In this regard, one of the theories applied most to the field of communication is regulatory fit theory (Higgins, 2000; Higgins et al., 2003), which claims that the degree of intensity with which an individual evaluates a choice largely depends on the fit between their motivational orientation and the framing of this choice. It is also interesting to note the seminal prospect theory, which claims that when messages are framed as gains (positive framing), people try to avoid the risk, while when messages are framed as losses (negative framing), they seek to identify the possible risks (Tversky & Kahneman, 1985; Penta & Baban, 2018). In both cases, if individuals are pursuing objectives in a way that matches their motivational orientation, they experience a regulatory fit that intensifies the evaluation of the objective pursued (Cesario *et al*., 2013).

In this vein, different studies show that making the content of a message match the framing tends to produce a regulatory fit; when this fit occurs, the message's capacity for persuasion produces positive results (Fransen et al., 2010), and therefore individuals evaluate the messages more positively in the fit condition (Lee & Aaker, 2004). Regulatory fit theory and seminal prospect theory are consistent with the Elaboration Likelihood Model developed by Petty and Cacioppo, (1986) which studies the process of persuasion through

two routes: central and peripheral, which determine the type of information processing. Multiple studies show that the level of attention paid to messages processed by the central route is much higher than messages processed by the peripheral route, and that the choice of either route to process information correlates directly with the individual's motivation. The higher the subject's degree of motivation to understand the message, the more likely it is that it will be processed via the central route.

In this sense, the importance of conducting in-depth studies of the motivational mechanisms underlying this persuasive process seems clear.

The goal of this study is to further this line of research and analyse not only visual attention but also emotion, emotional valence and motivation using integrated neurocommunication tools.

There are many empirical studies that have sought to study these variables using a methodology based on questionnaires or surveys (Mauss & Robinson, 2009). However, in the field of orienting responses, hardly any studies have been conducted that analyse motivation using highly precise, objective techniques, such as those provided by psychophysiology in the field of neurocommunication.

The use of these techniques enables these and other cognitive and motivational processes to be studied from a different perspective, providing new and highly relevant information to help us understand these persuasive mechanisms.

Several recent studies focus on studying visual attention using the Eye Tracking methodology; they analyse what type of message is the most effective, what information attracts the most attention and whether more processing of the information is related to a subsequent change in attitude (Fridman *et al.*, 2018; Cuesta *et al*., 2020). However, there are no previous studies that focus on studying (visual) attention, emotion and motivation based on the framing.

These three variables, (visual) attention, emotion and motivation, act jointly to generate a *psychophysiological and cognitive response pattern* which largely explains a subject's reaction to a given stimulus. This response pattern has often been studied under the concept of *orienting/defence responses* (Pavlov & Gantt, 1941; Sokolov, 1963). The orienting/defence response pattern is a set of psychophysiological responses in the subject when faced with a stimulus related to their behavioural reaction to any possible consequences it may have, providing the body with a clear adaptative value.

The orienting response, also called the orienting reflex, is a body's immediate response to a change in its environment whenever the change is not so sudden that is triggers the startle reflex (defence response). This phenomenon was described for the first time by Ivan Sechenov in his 1863 book, Reflexes of the Brain.

This study proposes and tests a methodology that enables us to study the *response patterns* (orienting vs. defence)in the field of persuasive health communication, more specifically in the field of persuasion regarding vaccination and public health according to the *type of framing of the message used* (gain vs loss). Initially, the following hypothesis was posed: a loss framing may generate a defence response pattern among young subjects, given that they perceive the loss framing as negative. Conversely, the gain framing should lead to an orienting response pattern, common to messages perceived as positive.

Consequently, if we show young subjects a message under the loss framing, a defence response pattern will be caused, while under the gain framing, an orienting response pattern will be caused.

To verify this hypothesis, we set out to research this *joint defence-orienting response pattern* by analysing the three most important variables involved: visual attention, emotion and motivation. The procedure used to evaluate these responses is the following:

- *Visual attention*, evaluated via Eye Tracking. The efficacy of this technique to measure both top-down and bottom-up cognitive attention has been proven, and it has been used in previous studies in the field of communication and health (Cuesta *et al*., 2019; Cuesta *et al*., 2020). The use of this tool not only enables us to ascertain the time spent reading the different messages (TTS or *Total Time Spent*) and consequently the cognitive attention spent on each of them, but also, via an analysis of the heatmap, we can determine which of the visual (and conceptual) elements of the message attracted the reader's attention the most.
- *Emotion*, evaluated jointly by analysing the facial expression and the skin's electrodermal or galvanic response. The electrodermal response has been proven to be a highly effective indicator of the emotion prompted, or arousal, but it essential to coordinate its measurement with an index that enables us to evaluate its *valence*, given that the electrodermal response only evaluates the *intensity* of the emotion, not its *direction*.
- *Motivation*, evaluated via prefrontal asymmetry using an EEG. Prefrontal asymmetry has been proven to be a valid indicator of the subjects' motivation with regard to a given stimulus (Astolfi *et al*., 2008; Vecchiato *et al*., 2012; Yilmaz *et al*., 2014).

That is, this study proposes both a theoretical model (the *orienting response* pattern) and tools (*EEG, GSR, Eye Tracking and Facial Expression*) which should enable an advanced, novel approach to studying the framing of the persuasive messages, and especially the underlying cognitive and emotional processes.

Considering that the orienting/defence response is presented as a *joint pattern* of psychophysiological responses, five hypotheses are posited which encompass the set of responses within this pattern.

Previous studies (De Dreu *et al*., 1994) have demonstrated that among youths, *gain framing* is preferred over *loss* framing. This preference is particularly notable in the field of communication and health campaigns, perhaps due to the importance the subjects attach to health (Rothman *et al.*, 2006). When the subjects attach more importance to a specific field, communication in this field is perceived as more relevant, and the stimuli take on a high *indicative value* for the organism's 'survival'. For this reason, giving a message a positive or negative framing can generate intense orienting or defence reactions.

According to the above, we can expect *gain framing* in a health-related message to generate an orienting response pattern, while *loss framing* would prompt a defence response.

Therefore, given that the sample was made up of young subjects (average age: 29), the five hypotheses proposed are:

H1: The type of framing will condition the amount of time the subject spends on the different concepts presented in the texts shown to them: gain framing will attract more attention to the positive concepts in the message, while loss framing will attract more visual attention to the negative concepts. These stronger 'focal points of attention' should be reflected in different visual heatmaps.
H2: The messages in a loss framing will produce longer cognitive processing time and therefore a higher level of visual attention than the messages in a gain framing, given that this type of framing runs counter to their cognitive preference. This should be reflected in the measures of 'total time spent' (TTS).

Skin conductance, also known as the electrodermal response, combined with measurement of the direction of the emotion, evaluated by unconscious facial micro-expressions, have been shown to be a suitable way to determine the intensity of the emotional response (GSR) and its valence (positive or negative, according to the facial micro-expressions). This enables us to posit the next hypothesis:

H3: Messages with gain framing will produce a stronger positive emotional response than messages with loss framing, evaluated via facial expression (valence of the emotion) and GSR (breadth and intensity of the emotion).

Finally, we can analyse brain activity and determine the motivation that a stimulus provokes via EEG, more specifically by evaluating prefrontal asymmetry: positive asymmetry (more prefrontal activity in the left hemisphere) indicates a cognitive/motivational state of attraction, while negative asymmetry (more prefrontal activity in the right hemisphere) indicates the opposite, that is, a cognitive/motivational state of rejection.

Therefore, the hypothesis would be:

H4: Messages presented via gain framing will prompt cognitive attraction (more prefrontal activity in the left hemisphere: positive asymmetry), while messages with loss framing will generate cognitive rejection (more prefrontal activity in the right hemisphere: negative asymmetry).

2. Method

Six subjects were chosen randomly among the staff of the Universidad Complutense de Madrid, who participated voluntarily (3 women and 3 men between the ages of 24 and 49). No subject claimed to be left-handed, so there was no need to discard any of them.

Two informative anti-vaccination texts were designed with identical content and length: one of the texts featured a gain framing, while the other identical message used a loss framing. These texts were created following the validity criteria established by the regulatory fit theory, according to the schema of similar studies (Glowacki *et al*., 2020).

As an introduction, the subjects were asked to imagine that they were going to visit a doctor to obtain information about the COVID-19 vaccine before the Christmas holiday, and the doctor gave them one of the two informative texts, which they had to read in detail. As the first step in the study, neurocommunication devices were placed on the subjects, and they were randomly presented with one of the two stimuli (3 students viewed the gain text and 3 the loss text). The sensors used to collect the data were:

1) Tobii Eye Tracking, a device that tracks the eyes by detecting the pupil using infrared light, establishes (heatmaps) and makes it possible to analyse the areas of interest (AOI) and the total time spent (TTS) by paying attention to the area of interest and variables like attention and the path gaze.
2) Shimmer records the GSR response, that is, the skin conductance, which enables us to record an increase in activity or emotional excitation, which sheds light on peak arousal.
3) Affectiva software connected to a high-definition camera tracks implicit facial micro-expressions. This technique records emotional states via observable gestures or micro-muscular changes to establish a positive, negative or neutral emotion (valence) as well as the degree of engagement.
4) EEG analyses cognitive attraction/rejection and motivation by measuring the asymmetry of the brain frequencies detected in the prefrontal zone (Davidson *et al.*, 2000). The Enobio device was used to monitor the EEG; this is a high-resolution unit to monitor and process the neural electrical signal with up to 32 channels. The signal from the prefrontal region was registered, and the measurement was based on the difference in power (asymmetry) between the two sets of electrodes placed on the left and right brain hemispheres. This signal was recorded continuously as the stimuli were being presented.

Once the signal was recorded, the iMotions software makes a spectral breakdown of the power according to the signals collected; it pre-processes the signal and calculates the motivation index by subtracting the alpha power transformed into a natural logarithm in the left hemisphere from the alpha power transformed into a natural logarithm in the right hemisphere. In this regard, if the power is the same in both hemispheres, the index is 0. However, if the power is stronger in the left hemisphere, the index turns negative, and vice-versa. Positive scores indicate an attraction motivation (pleasure), while negative ones indicate rejection (displeasure). In this case, because two different stimuli were used, the asymmetry scores have been interpreted relative to each other.

Before the stimulus was presented, the subjects were given the instructions to read the text on the screen, taking as much time as they needed, and once they finished reading it they needed to push the space bar on the keyboard to activate the end of the stimulus.

As they were reading it, the biometric variables described above were automatically recorded by the iMotions software system, which processed the indicators.

A factorial design of independent measures was created based on a single factor with two levels of experimental treatment.

The following was used as the independent variable:

1) Type of framing of the text, with two levels of experimental treatment: gain framing vs. loss framing.

The dependent variables were:

1) Level of visual attention paid to the different areas of interest in the text, evaluated via heatmaps.
2) Level of emotion, measured by GSR.
3) Positive or negative valence of the emotional response, measured via facial micro-expressions.
4) Cognitive state of attraction/rejection, evaluated by prefrontal asymmetry (EEG).

All procedures used during the research followed the protocols of the Research Ethics Committee of the Department of Communication Theories and Analysis of the Faculty of Information Sciences at the UCM.

3. Results

As shown in the heatmaps with the aggregate results of all the subjects in Figure 1, the visual fixations focus on the points of the message that are the most interesting to the subjects.

Figure 1. Heatmaps of the aggregate viewing of the gain vs. loss stimulus

Ganancia Pérdida

Source: Authors' own work

The analysis of these points enables us to establish an objective mean of the subjects' areas of perceptual interest. In the field of neurocommunication, heatmaps are very useful for detecting the overall areas of interest that prompt the subjects' attention to a given stimulus.

The results of the Eye Tracking with regard to hypothesis 1 (the type of framing will condition the amount of time spent on the different concepts in the text), confirm the following: the gain framing attracted attention more in the positive concepts of the message than did the loss framing, as measured via the heatmap: the subjects who read the 'gain' stimulus paid more attention to messages like 'you'll be able to travel and hold gatherings', while the subjects who read the 'loss' stimulus paid less attention to messages like 'getting the disease'.

With regard to hypothesis 2 (the time spent reading the message in the gain framing will be lower than the message in the loss framing), the data obtained from the Eye Tracking tool seem to verify the hypothesis, as the subjects that read the 'loss' stimulus took twice as long (26.19 sec) as the subjects who read the 'gain' stimulus (11.74 sec). Given that this study was semi-quantitative and exploratory (due to the sample size and the novelty of the theoretical framework), the conclusions regarding the hypotheses are indicative but not conclusive, as the sample size does not enable the hypotheses to be checked. In any case, the magnitude of the central tendency differences enable us to assume that the hypotheses point in the right direction.

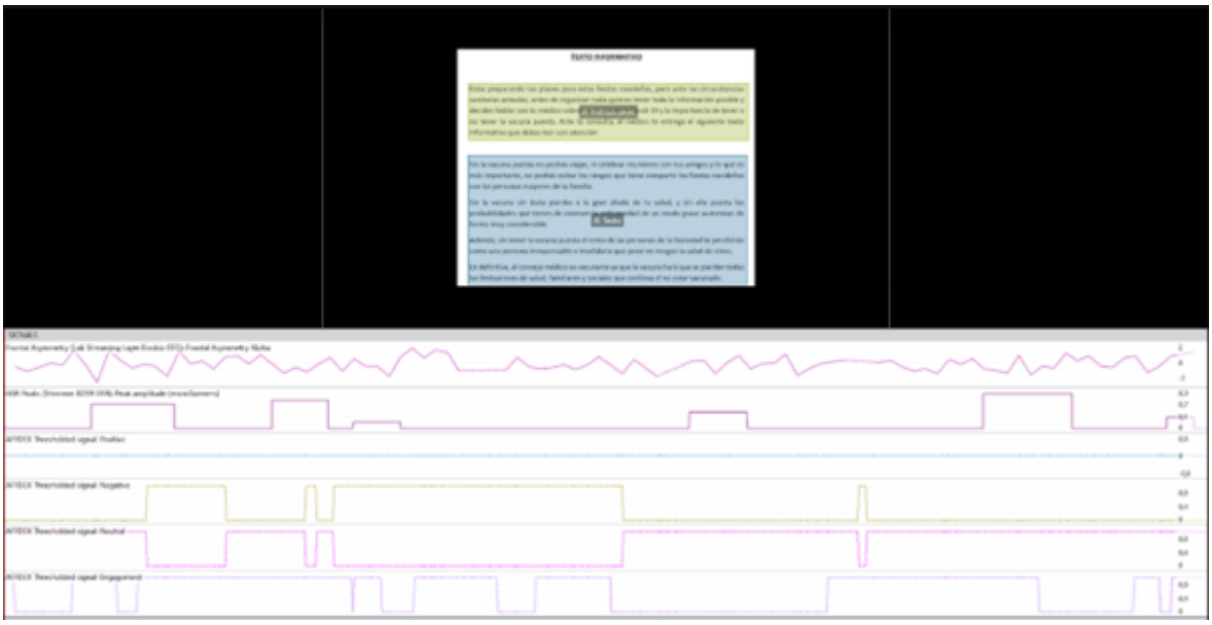
Figure 2. Table relating the stimulus seen with the reading time

Stimulus seen	Reading time
Loss	26.19 sec
Gain	11.74 sec

Source: Authors' own work

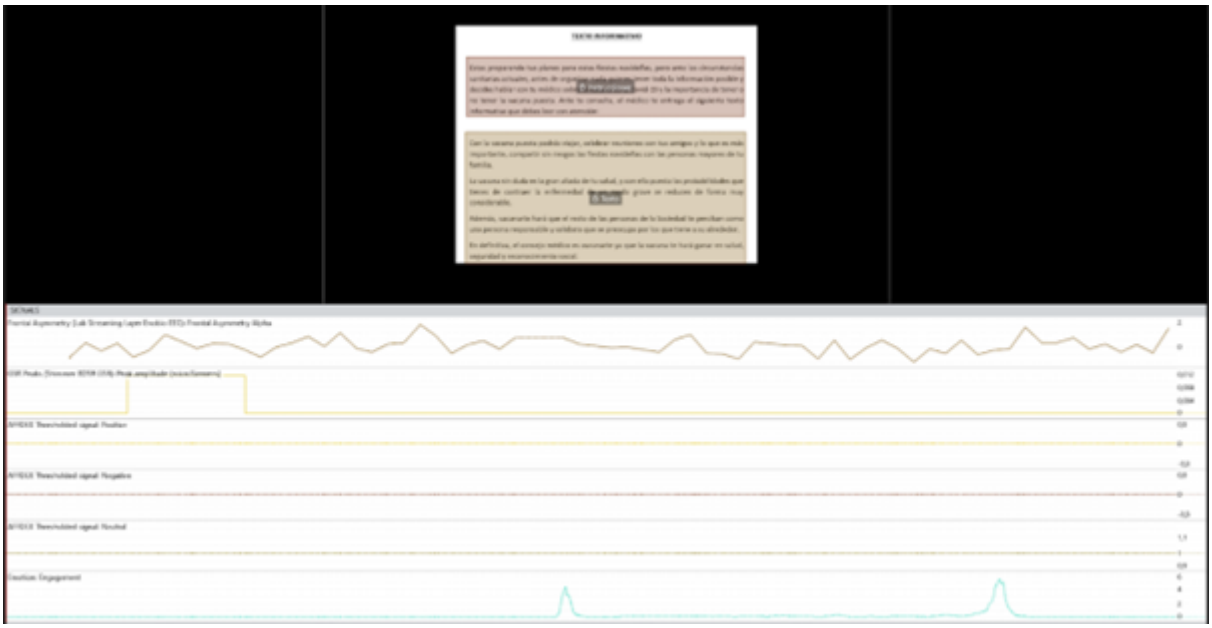
These results concur with studies based on the regulatory fit theory which state that a message's capacity for persuasion produces positive results if its content matches the subject's orientation and uses peripheral cognitive processing which leads to lower attention time (Fransen *et al*., 2010).

Figure 3. Results of GSR, facial expression and prefrontal asymmetry with a loss stimulus



Source: iMotions

Figure 4. Results of GSR, facial expression and prefrontal asymmetry with a gain stimulus



Source: iMotions

As shown in Figures 3 and 4 above, with regard to hypothesis 3 (the messages in the gain framing will produce a stronger emotional response than the messages in the loss framing), the data confirm a largely insignificant trend in favour of the hypothesis: the gain text generates more positive facial expressions (0.40%) than the loss stimulus (0.39%).

With regard to hypothesis 4 (messages using positive framing generate a more positive response than messages using loss framing), the measurements shown in Figures 3 and 4 are coherent with expectations, in that the loss stimulus generates more negative facial expressions (5.6%) than the gain stimulus, which did not generate any negative facial expressions (0%). Therefore, the verification of both hypothesis enables us to state that the messages in the gain framing generate a stronger emotional responses than the loss framing, and that these responses are positive.

Frontal asymmetry, measured via EEG, is one of the most advanced techniques for measuring and analysing short-term changes in the motivation that a subject experiences when presented with a stimulus. Different studies have shown that higher activity in the left prefrontal cortex indicates positive cognitive states, commitment and motivation (Davidson, 2004; Schaffer *et al*., 1983). Furthermore, recent studies have revealed that prefrontal asymmetry is a clear indicator of the respondents' commitment when they are exposed to different types of stimuli (Astolfi *et al*., 2008; Vecchiato *et al*., 2012; Yilmaz *et al*., 2014). In line with these findings, as shown in Figures 3 and 4, the data obtained align with the expected results, and hypothesis 5 (messages using gain framing will prompt more cognitive attraction than messages using loss framing) is totally confirmed. The data are

conclusive and indicate that prefrontal asymmetry is more negative when viewing the loss stimulus (-222,33) than the gain stimulus (-48.33). It is also interesting to note that the prefrontal asymmetry of the subjects who read the message promoting vaccines is more positive (-393) than that of those subjects who read a message about preventing the disease (-139.66). Therefore, we can state that the orientation towards promotion fosters more positive motivation.

4. Discussion and conclusion

The set of techniques that have reached neurocommunication from the field of psychophysiology has given researchers a powerful instrument for more precisely analysing certain psychophysiological variables. The objective of this research is to use an innovative perspective to study the psychophysiological response pattern that determines the visual attention, emotion and motivation variables, which as a whole can be considered a psychophysiological and cognitive response pattern which partly explains a subject's reaction to a given stimulus. This *pattern* has often been studied based on the concept of *orienting/defence responses*, which define the first level of reaction to an unfamiliar stimulus. This orienting/defence response (OR/DR) takes part in perceptive and attentional processes and materialises in a set of psychophysiological responses that the subject has when faced with a stimulus, which mobilises them towards an adaptive behavioural attitude. (Martínez, 1984).

Therefore, this research uses neurocommunication techniques to study this *response pattern* in the field of persuasive communication in communication and health, more specifically in the field of persuasion about vaccination and public health in relation to the *type of message framing* (gain vs. loss) used.

Recording these psychophysiological variables that shape the OR/DR enables us to conclude that in young subjects, in the field of communication on health and vaccinations:

- The messages delivered in a gain framing prompted a higher level of visual attention to the positive concepts included in the message as whole than the messages delivered in a loss framing.
- The subjects spent less time reading the message with the gain framing: the positive message required half the reading time than what was spent processing the message in the loss framing.
- The emotional response is stronger in the message in the gain framing, and it is always a more positive response.
- The positive cognitive state (attraction) and emotional state of the subjects, measured in terms of prefrontal asymmetry, is higher in the gain message.

All the above enable us to claim that among young people within the framework of health communication, the gain framing leads to a psychophysiological response pattern similar to the orienting response, while the loss framing is at the opposite pole.

This orienting reflex seems to be present since birth. It is extraordinarily useful in helping organisms react quickly to events that require immediate action and that the subject perceives as positive. In reality, the orienting reflex entails an 'opening' of the entire organism to the stimulus to prepare it for action. Thus, the subject's visual attention to the positive elements increases, they show a relatively intense positive response, they concentrate their cognitive attention to prepare for action, etc.

The orienting response presents an identical but opposite pattern: it prepares the organism to flee or defend itself. That is, when the organism is faced with a potentially threatening stimulus, it pays visual attention to the potentially harmful elements, the activity of its prefrontal cortex prepares for rejection and potentially negative emotions of fight or flight appear.

From the paradigm of neurocommunication, the evolutionary analysis of behavioural and psychophysiological patterns is particularly important. In this regard, the orienting and defence responses have often been used by evolutionary theory, according to which an organism's neuroendocrine system is designed to analyse its environs and constantly analyse stimuli to detect whether the indicative value of a stimulus indicates a potential value for survival (one's own or the species') or a potentially threatening value. A stimulus with an indicative value of survival will prompt orienting responses, while a stimulus with an indicative value of threat will prompt defence responses.

This study suggests a method of empirical analysis based on this idea of evolutionary origin to analyse subjects' psychophysiological responses when they are faced with relevant stimuli (as in the field of health) with a potential indicative value of survival (gain framing) versus stimuli with a potential value of threat (loss framing).

The analysis of these response patterns has obvious advantages. On the one hand, they enable us to objectively study the reaction caused in the message recipient, which may be very useful in different contexts, such as conducting pre-tests in different communication campaigns. On the other hand, they enable us to use highly precise recording and coding tools for biometric signals, introducing invaluable rigour into communication studies.

If this overall working hypothesis is confirmed, we would be laying the groundwork for the study of persuasive communication processes in the field of communication and health from a new and interesting paradigm, or at least presenting a novel theoretical and methodological approach.

Naturally, one important limitation of this study is the small sample size used, which makes it an exploratory study that would need to be complemented with studies with larger samples in the future. However, its novel methodological approach integrating visual attention, emotion and motivation variables doubtlessly paves the way for a new way of interpreting this type of study. The findings are important when implementing health communication campaigns and reveal that in order to promote vaccination campaigns among youths, the messages should be constructed from gain framing.

Future studies should not only considerably increase the sample size but also analyse gender, age, and sociodemographic differences. Likewise, the response pattern to different types of messages with different types of framing in different areas of health should be analysed. Furthermore, individual differences in the distinct types of information processing should be studied, given that this is a very important factor in this field and may lead to interactions with the type of framing and the responses they prompt.

Finally, it is important to expand the type of variables to be considered within the orienting/defence response pattern. For example, heart rate and inter-beat variability have been shown to be extremely important in the field of orienting/defence responses and show clearly inverse patterns: deceleration of the heart rate in OR and acceleration in DR. Similarly, pupillometry studies can provide extremely relevant data: pupil dilation indicates OR, while DR causes pupil contraction. Muscle tension, which is easy to evaluate via electromyography, can also be considered within this new paradigm: OR tends to cause muscle relaxation, while DR causes muscle contraction and tension in the tendon organs (like the Golgi tendon organ).

In short, the paradigm of orienting/defence response patterns opens up a broad spectrum of analytical possibilities from the theory and technique of neurocommunication regarding the effects of messages on audiences according to their indicative value and their potential of survival or threat, thus providing a sound point of departure for building solid, well-grounded theoretical models in the field of the communication sciences.

Author's contribution

Ubaldo Cuesta Cambra: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation and Writing – original draft. **José Ignacio Niño**: Investigation, Methodology, Resources and Supervision. **Carolina Bengochea**: Conceptualization, Software, Validation and Writing – review & editing; **Marion Roberts Martínez**: Methodology, Resources, Software and Visualization.

References

Astolfi, Laura; Fallani, Fabrizio; Cincotti, Febo; Mattia, D´Angelo; Bianchi, Lucien; Marciani, Maria Grazia; Salinari, Serenella; Colosimo, Alfredo; Tocci, Andrea; Soranzo, Ramon; & Babiloni, Fabio. (2008). Neural basis for brain responses to TV commercials: a high-resolution EEG study. *IEEE Transactions on neural systems and rehabilitation engineering, 16*(6), 522-531.

Castañeda, Carlos David; Martínez, Ronelsys; & Castro, Fernando de Jesús (2021). La vacunación y sus retos. *Revista Dilemas Contemporáneos: Educación, Política y Valores, 9*(119). https://doi.org/10.46377/dilemas.v9i.3032

Cesario, Joseph; Corker, Katherine; & Jelinek, Sara (2013). A self-regulatory framework for message framing. *Journal of Experimental Social Psychology, 49*(2), 238-249. https://doi.org/10.1016/j.jesp.2012.10.014

Cuesta, Ubaldo; Martínez, Luz; & Niño, José Ignacio (2019). Análisis de la información pro vacunas y anti vacunas en redes sociales e internet. Patrones visuales y emocionales. *Profesional de la Información, 28*(2). https://doi.org/10.3145/epi.2019.mar.17

Cuesta, Ubaldo; Niño, José Ignacio; Martínez, Luz; & Cuesta-Díaz, Victoria (2020). La importancia del emisor en las respuestas visuales implícitas y la persuasión. El caso de los antivacunas. En *Comunicación especializada: historia y realidad actual*. (Coord.) Joaquín Sotelo González, Jorge Gallardo Camacho, pp. 665-684. McGraw Hill.

Davidson, Richard (2004). What does the prefrontal cortex "do" in affect: perspectives on frontal EEG asymmetry research. *Biological Psychology, 67*(1-2), 219-234. https://doi.org/10.1016/j.biopsycho.2004.03.008

Davidson, Richard; Jackson, Daren; & Kalin, Ned (2000). Emotion, plasticity, context, and regulation: Perspectives from affective neuroscience. *Psychological Bulletin, 126*(6), 890-909. https://doi.org/10.1037/0033-2909.126.6.890

De Dreu, Carsten; Lualhati, Joselito; & McCusker, Cristopher (1994). Effects of gain-loss frames on satisfaction with self-other outcome-differences. *European Journal of Social Psychology, 24*(4), 497-510. https://doi.org/10.1002/ejsp.2420240407

Fernández-Niño Julián Alfredo; & Baquero, Hernando (2019). El movimiento anti-vacunas y la anti-ciencia como amenaza para la Salud Pública. *Salud UIS, 51*(2), 103-106. https://revistas.uis.edu.co/index.php/revistasaluduis/article/view/9528

Fransen, Marieke; Reinders, Machiel; Bartels, Jos; & Maassen, Ruth (2010). Té influence of regulatory fit on evaluation and intentions to buy genetically modified foods: The mediating role of social identification. *Journal of Marketing Communications, 16*(1-2), 5-20. https://doi.org/10.1080/13527260903342696

Fridman, Ilona; Ubel, Peter; & Higgins, E. Tory (2018). Eye Tracking evidence shows that non-fit messaging impacts attention, attitudes and choice. *PloS One, 13*(10) https://doi.org/10.1371/journal.pone.0205993

Gallagher, Kristel; & Updegraff, John (2012). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of Behavioral Medicine, 46*(1), 101-160. https://doi.org/10.1007/s12160-011-9308-7

Glowacki, Elizabeth; Bernhardt, Jay & McGlone, Matthew (2020). Tailored texts: An application of regulatory fit to text messages designed to reduce high-risk drinking. *Health informatics journal, 26*(3), 1742-1763. https://doi.org/10.1177/1460458219889279

Higgins, E. Tory (2000). Making a good decision: value from fit. *American psychologist, 55*(11), 1217. https://doi.org/10.1037/0003-066X.55.11.1217

Higgins, E. Tory; Idson, Lorraine; Freitas, Anthony; Spiegel, Sara & Molden, Daniel (2003). Transfer of value from fit. *Journal of Personality and Social Psychology, 84*(6), 1140-1153. https://doi.org/10.1037/0022-3514.84.6.1140

Larson, Heidi; Jarrett, Caitlin; Eckersberger, Elisabeth; Smith, Davey; & Paterson, Pauline (2014). Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007-2012. *Vaccine, 32*(9), 2150-2159. https://doi.org/10.1016/j.vaccine.2014.01.081

Lee, Angela; & Aaker, Jennifer (2004). Bringing the frame into focus: the influence of regulatory fit on processing fluency and persuasion. *Journal of Personality and Social Psychology, 86*(2), 205-218. https://doi.org/10.1037/0022-3514.86.2.205

López, Carmen María; González, José Luis; & Hernández, Alberto (2020). Consumo de información en redes sociales durante la crisis de la COVID-19 en España. *Revista de Comunicación y Salud, 10*(2), 461-481.

Martínez, José María (1984). Una revisión de los componentes del reflejo de orientación. *Anales de Psicología* 1, 167-180. https://revistas.um.es/analesps/article/view/32601

Martos, Jesús (2010). La información sobre la salud en los medios de comunicación. *Revista Española de Comunicación en Salud, 1*(2), 68-76. http://www.aecs.es/1_2_saludmedioscomunicacion.pdf

Mauss, Iris; & Robinson, Michael (2009). Measures of emotion: A review. *Cognition and emotion, 23*(2), 209-237. https://doi.org/10.1080/02699930802204677

Nasir, Laeth (2000). Reconnoitering the antivaccination web sites: news from the front. *Journal of Family Practice, 49*(8), 731-731. https://bit.ly/3AbtGAM

Olliaro, Piero (2021). What does 95% COVID-19 vaccine efficacy really mean?. *The Lancet Infectious Diseases, 21*(6), 769.https://bit.ly/3FDGW2t

Pavlov, Ivan; Gantt, W. Horsley; Volborth, Gregori; & Cannon, Walter (1941). *Conditioned reflexes and psychiatry.* International Publishers.

Penţa, Marcela; & Băban, Adriana (2018). Message framing in vaccine communication: a systematic review of published literature. *Health communication, 33*(3), 299-314. https://doi.org/10.1080/10410236.2016.1266574

Petty, Richard; & Cacioppo, John (1986). The Elaboration Likelihood Model of Persuasion. En *Communication and Persuasion.* Springer Series in Social Psychology. Springer. https://doi.org/10.1007/978-1-4612-4964-1_1

Piqueiras-Conlledo, Paloma; De Marchis-Picciol, Giorgio & Cuesta-Díaz, Victoria (2020). Análisis del contenido publicado en YouTube, Facebook e internet sobre vacunas y anti vacunas. *Revista de Comunicación y Salud, 10*(1), 67-90. https://doi.org/10.35669/rcys.2020.10(1).67-90

Rothman, Alexander; Bartels, Roger; Wlaschin, Jhon; & Salovey, Peter (2006). The strategic use of gain-and loss-framed messages to promote healthy behavior: How theory can inform practice. *Journal of communication, 56*(1), 202-S220. https://doi.org/10.1111/J.1460-2466.2006.00290.X

Sánchez, Laura P., de Frutos Torres, Belinda. y Martín, Alfonso G. (2020). La COVID-19 en la prensa española. Encuadres de alarma y tranquilidad en las portadas de El País, El Mundo y La Vanguardia. *Revista de Comunicación y Salud: RCyS, 10*(2), 355-384. https://doi.org/10.35669/rcys.2020.10(2).355-384

Schaffer, Carrie; Davidson, Richard, & Saron, Clifford (1983). Frontal and Parietal Electroencephalogram Asymmetry in Depressed and Nondepressed Subjects. *Biological Psychiatry,* 18, 753-762. https://bit.ly/3KnL2PS

Sokolov, Evgeny (1963). *Perception and the conditioned reflex.* Pergamon Press.

Tversky Amos; & Kahneman Daniel (1985). The Framing of Decisions and the Psychology of Choice. In Wright G. (Eds.) Behavioral Decision Making. Springer. https://doi.org/10.1007/978-1-4613-2391-4_2

Valenzuela, María Teresa (2020). Importancia de las vacunas en salud pública: hitos y nuevos desafíos. *Revista Médica Clínica Las Condes, 31*(3), 233-239. https://doi.org/10.1016/j.rmclc.2020.03.005

Vecchiato, Giovanni; Toppi, Jlenia; Astolfi, Laura; Cincotti, Febo; De Vico Fabrizio; Maglione, Anton Giulio; Borghini, Gianluca; Cherubino, Paolo; Mattia, Donatella; & Babiloni, Fabio (2012). The added value of the electrical neuroimaging for the evaluation of marketing stimuli. *Bulletin of the Polish Academy of Sciences Technical Sciences, 60*(3), 1-8. https://doi.org/10.2478/v10175-012-0053-2

Yilmaz, Bülent; Korkmaz, Sümeyye; Arslan, Dilek Betül; Gungör, Evrim; & Asyali, Musa (2014). Like/dislike analysis using EEG: determination of most discriminative channels and frequencies. *Computational Methods and Programs in Biomedics, 113*(2), 705-713. https://doi.org/10.1016/j.cmpb.2013.11.010

Zimmerman, Richard; Wolfe, Robert; Fox, Dwigth; Fox, Jake; Nowalk, Mary Patricia; Troy, Judith; & Sharp, Lisa (2005). Vaccine criticism on the World Wide Web. *Journal of Medical Internet Research, 7*(2), e17. https://doi.org/10.2196/jmir.7.2.e1