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Design and assessment of an experimental model for evaluating the effectiveness of audiovisual products on the circular economy aimed at promoting environmental awareness

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ABSTRACT

Communication is crucial to encourage citizens to adopt sustainable habits, but the effectiveness of awareness-raising actions in the last decade has been limited. Therefore, it is essential to invest efforts to understand and improve the effectiveness of environmental awareness actions. This research aims to design an experimental model to evaluate the effectiveness of audiovisual products on ecological transition and circular economy for young people based on a classical narrative model. To this end, the discourses of communication experts obtained through the elaboration of 10 semi-structured interviews are analysed (using the grounded theory method). Subsequently, an evaluation model is designed, validated and tested by conducting a quasi-experiment with 59 high school students who are exposed to two stimuli (A and B) in groups, as well as to a pre-test and post-test, using neurocommunication systems. Firstly, the interview analysis results allow us to identify intermediate objectives, strategies and characteristics of the communicative products that could increase the effectiveness of the communication actions. Secondly, the results of the quasi-experiment allow us to evaluate the experimental model designed to measure the effectiveness of communication products. As a result of the whole process, a model for evaluating the effectiveness of audiovisual products is obtained, which allows the identification of the aspects that increase awareness campaigns' effectiveness. Despite the limitations of the model, the great potential of using traditional and neuromarketing research techniques to identify aspects that improve the communication of ecological awareness campaigns is determined.

1. Introduction

Citizens' involvement in the transition from a linear economy to a circular economy (CE) (Comisión Europea, 2020) is essential to achieve the objectives set by the European Green Deal (Comisión Europea, 2019) and the NextGenerationEU Recovery Plan (Comisión Europea, 2021).

Communication and marketing actions are crucial in empowering citizens to consume responsibly, strengthening the demand for sustainable products, and improving the protection of this demand through information tools (Comisión Europea, 2020). In this way, they can contribute to achieving the 12th Sustainable Development Goal (SDG): *ensure sustainable consumption and production pattern* (United Nations, 2019) and the aims of the 10-year Framework of Programmes on Sustainable Consumption and Production Patterns (United Nations, 2022), goals also shared by the Advertising and Marketing Code of the *International Chamber of Commerce's Advertising* (International Chamber of Commerce, 2018). They also promote dialogical models between science and society and promote Responsible Research and Innovation (García Marzá et al., 2018), which raise citizens' awareness of their role in global change processes and their capacity to intervene and participate in building a sustainable society (García-Castillo et al., 2020).

Environmental awareness should seek a clear and reflective understanding of the problems facing humanity and foster the capacity to intervene at both the individual and collective levels. However, changing consumer behaviour is complex and requires changing long-established beliefs, attitudes, and habits. This needs critical and reflective approaches emanating from both environmental communication (Bolin and Hamilton, 2018) and Environmental Sustainability Education

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(ESE) incorporating the eco-media and digital dimensions (Rodrigo-Cano et al., 2019).

Despite the numerous efforts made over the last three decades (Green et al., 2019), as recently recalled by the Intergovernmental Panel on Climate Change (IPCC, 2022), the actual results achieved are still very limited. From a communication perspective, there is intense debate on what are the most effective strategies and narratives to promote responsible and sustainable behaviour and consumption (Holland, 2019; Lee and Kotler, 2019). In particular, it is about how to achieve informative and persuasive communication that bridges the attitude-behaviour consistency gap (Blake, 1999; Kollmuss and Agyeman, 2002). In other words, it is still unknown how to most effectively motivate inactive people who are already aware of the problem and do not act accordingly. In order to analyse which are the most appropriate models for creating an engaged citizen consciousness that goes beyond ecogestures (Abbati, 2019) to build atomic habits (Clear, 2019), it is necessary to evaluate the effectiveness of the audiovisual narratives consumed specifically by young people about the impact of their consumption on global sustainability. From the knowledge provided by studies focused on the macro-narratives of environmental discourse, we identified the necessity of going down to the analysis of how individual exposure to specific audiovisual products operates to understand, through experimental studies, the effect of narratives on perception and attitude change.

The state of the art shows that it is possible to develop a tool based on neuromarketing techniques to evaluate the effectiveness of audiovisual products whose aim is to promote sustainable habits, since the associated knowledge can help to improve the impact of these actions. A literature review and a Desk Research were conducted to find out if there is a model for evaluating the effectiveness of audiovisual products aimed at changing habits towards CE using neurocommunication techniques. Having established the absence of such a model, the research hypothesis (RH) is formulated:

- RH. Neuromarketing techniques, such as facial recognition and eye-tracking, improve the effectiveness of the evaluation model for audiovisual products designed to promote habit change.

The general research objective (GO) is derived from RH:

- GO. To design an experimental model to evaluate the effectiveness of audiovisual products related to a CE in a young population (15–17 years old).

Based on the GO the following specific objectives (SO) are set out:

- SO1. To determine the narrative characteristics that communication products should have to raise environmental awareness, according to the opinion of communication experts, in order to establish the attributes of the stimuli to be used for the experimental model.
- SO2. To develop and test an experimental model to evaluate the effectiveness of audiovisual products, based on the use of an A/B test with pre-test and post-test through Affectiva Emotion Analytics Dashboard (AFFDEX) analysis and eyetracking, with a sample of young high school students between 15 and 17 years old from the Community of Madrid.

After formulating the objectives, the development of SO is conducted in two phases. In the first phase SO1 is implemented, in the second SO2. The efforts carried out in the first phase are inductive in nature and allow for the development of a theoretical hypothesis (TH) that contributes to the creation of the audiovisual stimuli that enable the implementation of SO2 (Fig. 1).

This study provides an experimental model to evaluate the impact of audiovisual products designed to stimulate habit change. The model provides a validated research instrument that could significantly contribute to reducing the existing gap that prevents people from acting more sustainably and promoting the transition to CE.

2. Theoretical background

2.1. Creating a pro-environmental attitude through communication and social marketing

In the behavioural sciences, nudge theory (Thaler and Sunstein, 2008) has documented how positive reinforcers (default choice, social heuristic testing, availability …) can help improve the effectiveness of actions aimed at shifting from an intention to consume sustainably to appropriate behaviour (Spash and Dobernig, 2017). Although it has been criticised by behavioural economics studies from an ethical perspective because of the risk of manipulating behaviours (Guldborg Hansen and Maaløe Jespersen, 2013), its fundamental approaches are useful for application in the analysis of communication products designed to promote sustainable behaviours. Also, for example, to assess the rebound effect (Heras, 2009) of bad social marketing under the guise of greenwashing (Lukinović and Jovanović, 2019), sometimes taking advantage of large events such as the United Nations Climate Change Conferences (COP) (Heras, 2009).

Storytelling has become a basic strategy for constructing narratives in environmental (Comfort and Park, 2018; Jones and Peterson, 2017) and sustainability discourses (Fischer et al., 2020). Narrativisation based on supportive persuasion uses the catalytic capacity of screens (Ferrés Prats, 2014) to construct emotion-based narratives that exploit the function of mirror neurons (Rizzolatti and Craighero, 2004). Neuromarketing studies have shown that stories with an affective component are more likely to produce immediate attitudinal change, especially if they are aimed at immediate conversion (Berman et al., 2018). However, stories with a more cognitive structure offer a deeper outcome associated with greater and sustained recall (Hamelin et al., 2020), which is necessary for profound behavioural change towards sustainable

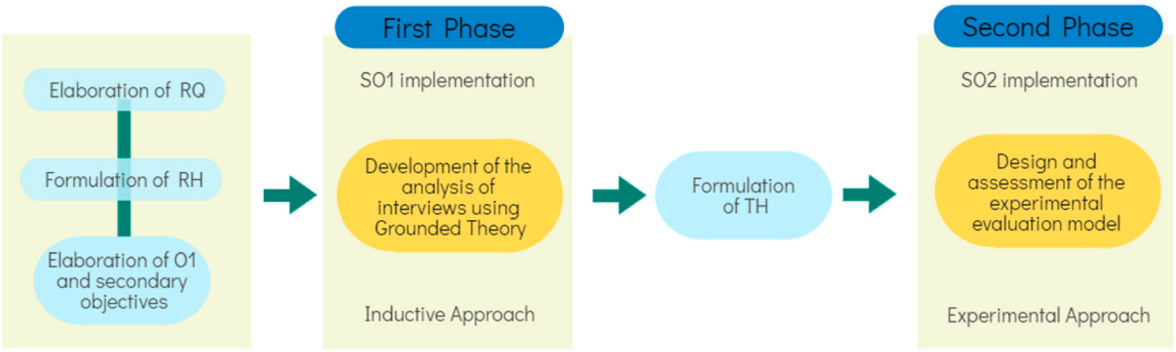


Fig. 1. Research design process.

consumption (O'Rourke and Lollo, 2015). Studies on the visual communication of sustainability and climate change have concluded that messages that propose solutions are more effective than those that only present the negative perspective of the impact of consumption on sustainability (Chapman et al., 2016), as they offer mechanisms for action and propose alternatives (Gerst et al., 2021). Media discourses should therefore help generate positive emotions in youth to reduce climate anxiety (Clayton and Karazsia, 2020) and give them hope, an essential motivator for pro-environmental behaviour (Bissing-Olson et al., 2016) and committed environmental citizenship (Kerret et al., 2016). Nevertheless, this does not mean preference should be given to those audiovisual products that generate more attraction and motivate greater engagement, at least in the short term (Kapoor et al., 2021). These products should also be designed from a user experience perspective (Gruen et al., 2002) and involve not only experts in communication but other societal actors (Servaes and Lie, 2015).

2.2. Evaluation of the effectiveness of audiovisual products for sustainable behaviours in social marketing campaigns

The use of audiovisual communication products has been proven to be effective when it comes to increasing the interest and memorability of young people (Ho and Intai, 2017). Some of the most recent systematic literature reviews (Rejeb et al., 2022) highlight the importance of evaluating the effectiveness of social marketing and *green marketing* communication actions and products (Groening et al., 2018) including the application of experimental and quasi-experimental methods (Truong et al., 2021), as well as neuromarketing techniques (Leeuwis et al., 2022; Zito et al., 2021).

From the perspective of social impact (Domegan, 2021) and the theory of change (Ebrahim and Rangan, 2014), these methodologies enable the application of more precise evaluable indicators in the five steps of the logic model of change attribution (Muller and Fontrodona, 2020), which can be useful to understand how a communication product (activity, output) can be improved to obtain greater outcomes (impacts) and thus optimise those drivers of attitude change, such as pure altruism (de Morais et al., 2021), which are more useful for the goal of ultimately changing consumer behaviour.

Despite the extensive literature that focuses on measuring the effectiveness of climate change communication actions (Kidd et al., 2019), the lack of standardized instruments that could help increase the effectiveness of communication campaigns is evident. Although some authors approach the study of communication effectiveness by means of quantitative analyses (Rizzi et al., 2020), non-standardized instruments are used. The study of Taufique et al. (2016) highlights the need to incorporate methods that allow researchers to deepen their understanding of messages that promote change in people's attitudes and behaviour (Mefalopulos, 2005).

2.3. Definitions and terminologies

For this research, the following definitions are used:

- Environmental awareness. A systemic set of experiences, knowledge, and experiences that make up the imagination and the model of each individual's relationship with the environment (Febles, 2001).
- Effectiveness. Ability to generate greater attention and critical reflection to bring about a change in more sustainable consumption habits.
- Circular economy. "Economic system that replaces the concept 'end-of-life' with reduce, alternatively, reuse, recycle and recover materials in production/distribution and consumption process" (Kirchherr et al., 2017, p. 229).
- Ecological transition. The process of transformation from the current production model based on the line economy (extractive, which does not consider the environmental footprint and its consequences) to a social and greener one based on the CE and the blue economy (García, 2018)

3. Methodology

3.1. Methods and techniques

The research combines different methods, which were conducted in two phases (Fig. 2). First, semi-structured interviews with communication experts were analysed using grounded theory. This revealed the need to develop experimental models to evaluate the effectiveness of audiovisual products. Second, we propose the design and testing of an evaluation model that includes the creation of a model product and its evaluation through an A/B test with pre-test/post-test, and the use of neurocommunication systems.

3.2. The discourse of communication experts: semi-structured interviews

The collection of information for this first methodological approach was carried out between March and July 2020 through semi-structured interviews (N = 10) with communication professionals (from academia and/or the advertising or corporate communication sector). They were conducted online and recorded to be first automatically transcribed with sonix.ai software and then manually reviewed to correct typos. The questionnaire used was previously validated through expert judgements (Escobar-Pérez and Martínez, 2008) by 8 academics and communication professionals who evaluated the univocity, relevance, and importance (Zambrano Díaz, 2017) of the items. A self-administered form was used for this purpose (Lavrakas, 2008). After validation, the questionnaire was created (Romero-Luis et al., 2022), consisting of 4 questions ranging from general to specific about communication for awareness raising in the field of CE. Before conducting the interviews, the experts were provided with the signed consent form approved by the URJC Research Ethics Committee (Internal Register, 1806201910519).

Grounded theory (Corbin and Strauss, 2008) was used to analyse the transcripts. This qualitative method follows a structured process involving the constant comparison technique and in vivo, axial and selective coding of the data. Through the temporal and spatial recognition of contexts (Flick, 2018), this methodology allows for understanding the object of study and theorising about it, as well as better understanding the perspective of a population segment (Clarke and Friese, 2007) to generate hypotheses that can be carried forward into future long-range studies. It is based on the principle that affirms that a complex social system is equal to the sum of its parts (Cardozo Brum, 2011), whose liquid nature generates a high degree of uncertainty (Bauman, 2013), which influences the social system in a non-linear way (Sánchez-Gutiérrez, 2000). The analysis focuses on three thematic areas revolving around social communication for awareness-raising: intermediate communication objectives to promote behavioural change, communication strategies and product attributes, and communication actions to achieve their effectiveness (Fig. 3).

Following the grounded theory model, the analysis was directed towards the formation of a formal hypothetical model. Since the purpose of this analysis is not to theorise, the results suggest that there is a need to delve deeper into the aspects that determine the success of awareness-raising campaigns. The finding motivates the generation of the TH and the implementation of the design, validation, and realisation of the quasi-experiment, phase 2 (Fig. 2).

3.3. Quasi-experimental research

3.3.1. Sample

A quasi-experiment (Martínez León et al., 2018) has been developed with high school students from the Instituto de Educación Superior Dionisio Aguado in Fuenlabrada, in the south of the Community of Madrid, Spain. The data collection was carried out in November 2022

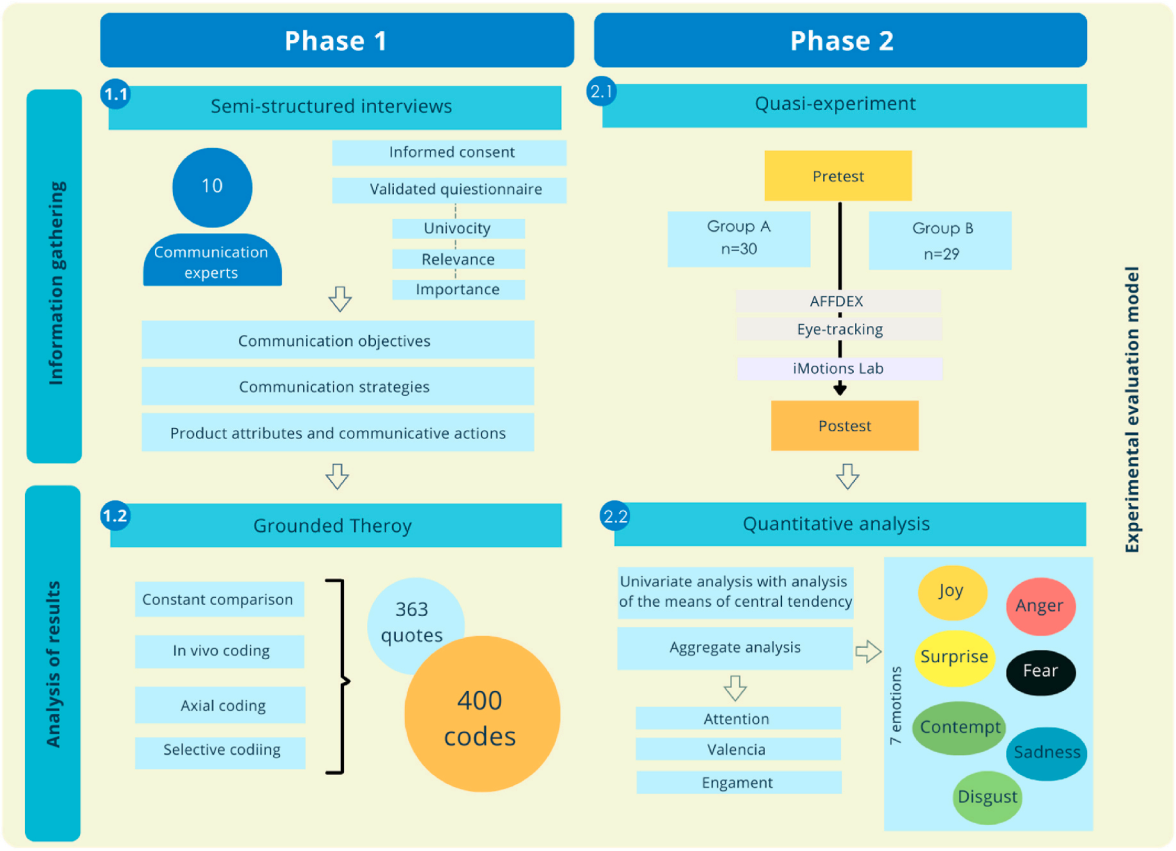


Fig. 2. Methodological design.

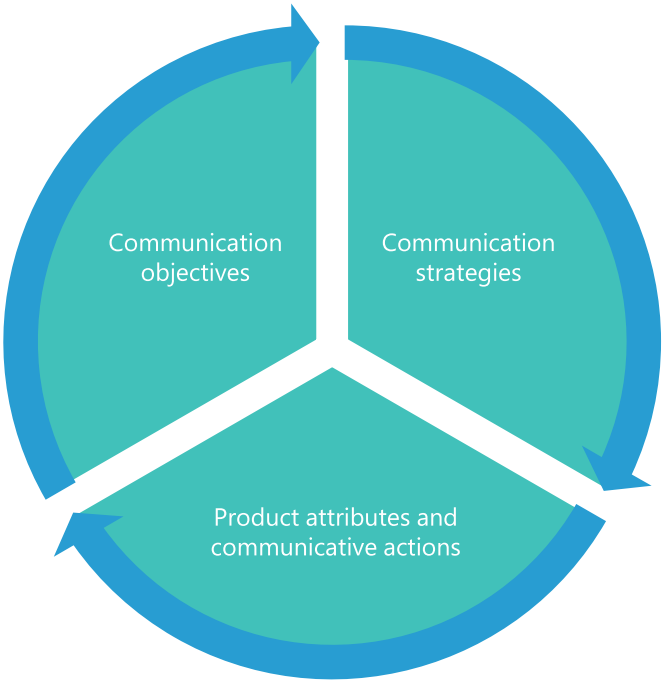


Fig. 3. Thematic vertices of grounded theory analysis.

and involved 59 students aged between 15 and 17 years. The subjects were selected using a non-probabilistic convenience sample. The sample size was considered sufficient for the study purpose, which is evaluating the viability of the model and is not aimed at being a representative sample. The age of the participants was chosen to maintain the focus on the youth, considered an essential target group for the media to increase their motivation (Bissing-Olson et al., 2016) and commitment towards climate change (Kerret et al., 2016). They were randomly divided into two groups (control and experimental), which were exposed, by the A/B test procedure, to two different stimuli. Group A consisted of 30 students (15 females, 14 males, and one person who preferred not to declare their gender), and group B consisted of 29 (15 females and 14 males). In addition, subjects were subjected to a pre-test and a post-test (Table 2) before and after viewing the stimulus. Participants signed a consent form approved by the URJC Research Ethics Committee (internal register 1806201910519).

3.3.2. *Stimuli*

The stimuli used for the quasi-experiment were created *ad hoc* with a similar duration (2 min) and identical narrative structure, responding to Freytag's (1894) pyramid mode or Aristotelian framework, which is composed of the introductory phase, the incremental action phase (culminating in the climax), the falling action phase, and the conclusion or closure (Fig. 4). The topic of the videos revolves around mobile phones and the negative environmental and socio-economic impact of their use in Europe. This topic was chosen because the mobile phone arouses the interest of adolescents (Yoon and Yun, 2021) and 98.5% of them use it and replace it every 1–2 years (Pérez de Albéniz Garrote et al., 2021).

The content of the videos is based on "Conflict Free Technology" campaign (Alboan, 2019). Both videos, informative in nature, share the problem statement to the climax: the exorbitant consumption of mobile devices in developed countries encourages illegal gold trafficking in Colombia, resulting in consequences for the population that go against human rights. Then, video A (https://youtu.be/vRXJh41c_Lc) offers a direct and simple solution to call the viewer to action through two

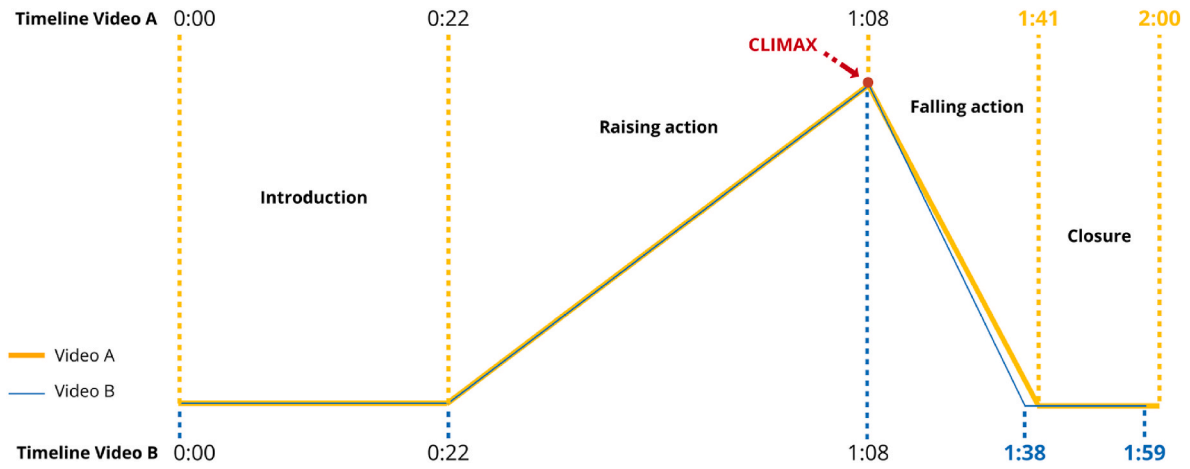


Fig. 4. The narrative structure of the stimuli (based on Freytag (1894) model).

simple actions: reduce the use of mobile phones and recycle them. In video B (https://youtu.be/xW6rj23HiAg) there is no direct solution and no appeal to individual responsibility (Table 1).

3.3.3. Instrument validation

For the validation of the pre-test and post-test questionnaires, an evaluation by expert judges was used (Escobar-Pérez and Martínez, 2008). Using a self-administered form (Lavrakas, 2008), 11 communication specialists, academics, and practitioners, with at least 5 years of experience in the field, assessed the univocity, relevance, and importance (Zambrano Díaz, 2017) of the items. The experts also validated the stimuli to assess the suitability of the narrative model and the language used. For the validation of the instrument, the Fleiss kappa statistic (Fleiss et al., 2003) was used resulting in a value of 0.655, which is in the good range. This statistic shows the degree of agreement between three or more observers/evaluators on a categorical Likert scale variable.

Cronbach's alpha was applied to validate the reliability of the measuring instrument for assessing the attitude of students toward responsible consumption. Students' attitudes were considered as predictors of behaviour through their evaluation of a social object such as the smartphone (Rodríguez, 1991). A Cronbach's alpha of .694 and .704 was obtained for 59 items based on standardised items.

After the validation process, the final questionnaire was formalized with the questions included in the pre-test and post-test. An additional question was added in the post-test to self-assess the respondent's predominant emotion while watching the video. Table 2 sets out the relational model between the constructs, which are specified from the first to the third level, the variables, and the test questions.

3.3.4. Data collection

The data collection of the quasi-experiment was carried out in different stages: 1) Administration of a pre-test questionnaire and recording of responses; 2) Individual exposure to the test item (A or B) and collection of information using the AFFDEX and eye recognition modules of iMotions Lab© system; 3) Administration of a post-test questionnaire and recording of responses; and 4) Data analysis.

The first stage took place on the November 8, 2022 at the URJC. The students were asked to sign the informed consent form and to answer the pre-test during the workshop organised by the Ciberimaginario research group on the occasion of the 22nd Science Week.

The second stage took place on 9 and November 10, 2022. The researchers travelled to the Dionisio Aguado educational centre in Fuenlabrada and set up a set with two areas separated by a room divider (Fig. 5). At this stage of the quasi-experiment, data was collected using iMotions software version 9.3. This *software* is designed for professional and academic research and allows data to be collected and analysed using a *webcam* (which collects images at 30 Hz) and eye recognition *hardware* (Smart Eye AI-X model; which collects information at 60 Hz). The webcam data is collected through a facial expression recognition module called AFFDEX which processes the images and analyses the subjects' facial micro-expressions. This algorithm is based on Ekman and Friesen's Facial Action Coding System (FACS) model (1978) and recognises action units, such as eyebrow-raising, smiling, mouth opening, etc. (Farnsworth, 2022). The algorithm uses those units to classify seven emotions: joy, anger, surprise, fear, contempt, sadness and disgust; and three indicators: attention, valence, and engagement (iMotions, 2022).

The following procedure was followed for each subject: 1) the subject is invited to sit comfortably in front of the computer, put on the headphones, and move the fringe away from the forehead if present; 2) a new subject is generated in the iMotions software, including the subject's name; 3) the researcher selects the stimulus to be viewed by the subject (A or B); 4) the eye recognition system is calibrated; 5) the selected stimulus is displayed; 5) the selected stimulus is viewed. Before stimulus playback, students viewed an initial 30-s video with nature images and

Table 1
Screenshots of stimuli.

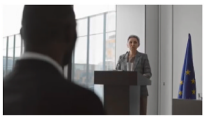
	0:22	1:19	1:49
Video A			
Video B			

Table 2
Model of elaboration of the pre-test and post-test questions based on the constructs.

Level 1 construct	Level 2 construct	Level 3 construct	Var.	Questions
Environmental awareness of the CE	Change in consumer habits	Readiness to change	V1	If I could, I would change my smartphone every time a newer model is released.
			V2	If I could, I would change my phone only when it starts to run slower than normal and takes a long time to load applications.
			V3	If I could, I would replace my smartphone every time I found a flaw (such as a scratch or a broken screen) even if it was still working.
			V4	I would only consider replacing my smartphone when it stops working completely or is not repairable.
			V5	I believe that constantly changing mobile phones are not responsible because it consumes a lot of resources and has consequences for people's lives.
		Constraints to change	V6	I consider having the latest smartphone model to be important because it influences what others may think of me.
			V7	If I could, I would have a more modest mobile phone to give a good image to others.

Fig. 5. Set installed in the room where the information from the second and third stages was collected.

the sound of birds chirping. This provided a safe time for the researchers to leave the set.

In the third stage, immediately after viewing the stimulus, students were asked to answer the post-test questionnaire. The entire process of the second and third stages lasted between 6 and 7 min per participant.

3.3.5. Data analysis

Before starting the analysis, the data were anonymised in both the pre-test and post-test results as well as in the data collected from the visualisation of the stimuli.

For one thing, the pre-test and post-test responses were compared through univariate analysis with analysis of the means of central tendency. Given that the questionnaires had Likert-type responses, the data were coded numerically using Excel to facilitate the calculation of the difference in response between the pre-test and post-test. The values were coded as follows: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). The difference in response per question and group was calculated, and the results were compared between group A and B to identify the degree of variation between the responses of the two groups before and after viewing the subjects. Subsequently, an analysis of variance (ANOVA) both between-group and within-group was computed using SPSS to assess the existence of significant differences between the groups according to the seven variables studied on the pre-test and post-test.

For another thing, the data collected were analysed with the iMotions software. The indicators collected by the AFFDEX algorithm are displayed on a scale between 0 and 100, with 0 being completely absent and 100 being strongly present. To ensure the reliability of the data, it is recommended to set an arbitrary threshold of 50 (iMotions, 2022). In this analysis, the threshold has been set so that only values above 50 are considered, the others being discarded.

The results of the aggregate value of the seven emotions are analysed independently. In addition, indicators of attention, valence and engagement are analysed. The attention indicator is based on the position of the head and the position of the gaze while the subject is viewing the stimulus. The valence indicator shows the positive or negative nature of the expression. And the engagement indicator relates to the emotional reaction that the subject has to the stimulus. The value corresponding to the number of people with values above 50 in each of the indicators is obtained, concerning the timeline, and the average of each indicator per section of each of the stimuli is calculated.

4. Results

4.1. Grounded theory

Experts argue that promoting behavioural change is a key conversion target when designing awareness campaigns. They agree that "there is no master formula" to achieve the effectiveness of communication actions, but the analysis envisages two intermediate objectives that become relevant to approach the goal of habit change conversion: to generate attention and to call for action. The first is considered key to generating visibility and interest.

> An awareness campaign is successful the moment the media talks about it […] What I'm trying to tell you is that the first phase is to get their attention, that's the key.

Generating attention is the first step and allows your message to reach more people, but raising awareness also requires pursuing the second step. "If you want to call to action, to change behaviour, you can't stop at that. Visibility alone is not going to work for you."

The complexity of the environmental problem makes it difficult for communication actions to be effective, so for a communication action that calls for action to be effective, the recipient must be aware of the scope of the problem. Therefore, promoting knowledge of the scope of the problem is another intermediate objective that becomes relevant in

the experts' discourse. "The second thing you would need is to have concrete data to prove that this problem is indeed very harmful to a specific group, for humanity as a whole, for the environment, for whoever …"

Similarly, to increase the effectiveness of communicative actions that call to action, knowledge about the consequences of such actions should be promoted. One of the experts gives an example of waste recycling:

> There are increasing questions about what happens when I throw plastic in the yellow bin, where does it go? What happens when I recycle glass? […] Is a private company benefiting solely and exclusively? Does that private company separate well, or does it not separate well? What is done with the rest that is not recycled? Where does it go?

Unlocking certain unknowns to the recipient increases the likelihood that the call to action will be more successful and lay the groundwork for habit change.

4.1.1. Communication strategies to achieve the objectives

The analysis of the experts' speeches reveals two strategic approaches that could help awareness-raising campaigns to be more effective. Without explicit reference, most experts refer to the concept of user-centred design. Knowing the audience is necessary to be able to construct the message and its form. When the audience is young, this aspect becomes even more important:

> Hacking their language, hacking their platforms, that someone who is from another generation […] suddenly speaks to you in your language or on your platform, or through your communication channel, which is mobile … […] That would be …, how to break that barrier of disinterest.

On the other hand, the second strategic approach that emerges from the experts' discourse is to construct messages that establish an emotional link between the viewer and the message. While this is something that is commonly applied in commercial advertising, it could be very effective in achieving the communication objective of an awareness campaign. The analysis does not disclose in detail which emotions should be referred to, but some experts favour positive emotions, such as joy or happiness. Others are negative, such as fear or guilt.

4.1.2. Attributes of communicative products and actions to be effective

Regardless of the objectives pursued or the strategy used, an awareness-raising campaign always takes the form of actions and products. The experts' discourse shows an agreement between certain characteristics that communication products or actions must have to be effective, but also certain contradictions.

Experts agree on one point: the viewer must be actively involved. When targeting a young audience this can be important. Participation is an attribute that connects with the "experiential" aspect of awareness-raising actions, which should be accompanied by a playful aspect. "It's more important the emotional benefit you get when you do it."

Similarly, aspects such as novelty, originality, and the use of appropriate codes must be present to capture the attention of young audiences. "We have to communicate in a fresh, disruptive way, in the channels where young people are and with the codes they use." Moreover, experts agree that messages should be simple, direct, and easy to understand.

On the other hand, the analysis shows contradictions. Some argue that campaigns should focus on the solution in a light and fun way. "I don't think they are campaigns that have to look so much at the problem, but at how you get the solution, that it's fun for everyone, especially when you talk to a child". While others advocate appealing to the more devastating aspects of the problem to allude to more powerful emotions:

> It is generally essential that you describe a problem, and that this problem has a solution, and that when looking for that solution you rely on one of two things: either on data that support that this problem is indeed bleeding and has a solution, or on personal stories that embody, let's say, the negative consequences of your problem of writing this.

Contradictions are also identified concerning appeals to individual or collective responsibility. While the analysis favours the former, there is no agreement among experts on this aspect.

> There is an individual part of each necessary individual, and it is not because it is easy, it is not because you are being paid, it is not because it is remunerated, it is not an issue that you do it because you see an immediate benefit, but because there is a part of awareness of, I repeat, not only towards ourselves but towards others.

Although the analysis shows results on which attributes could enhance the effectiveness of communication products and actions, there is a unanimous view that is reflected in the following quote:

> Communication has this, that there are as many ways to reach and be effective as there is a wealth of creativity and resources that one can invent to change behaviour and make people think. If only there was a palette of 'look, you use these colours, these resources, and then you're sure to succeed'.

The results of the analysis reveal the need for communication experts themselves to investigate in depth the determinants of a successful awareness-raising campaign. Furthermore, allows the generation of the TH that permits the establishment of the narrative and attributes of stimuli to be assessed with the experimental model:

- TH: The messages that promote sustainable habits must be simple, direct and easy to understand, showing the gravity of the problem and appealing to individual responsibility to generate a greater impact on the receiver.

4.2. Quasi-experiment

The analysis of the pre-test and post-test responses shows a very low degree of variation between the two questionnaires, both in groups A and B. Although group B has a greater degree of variation between the pre-test and post-test responses, the difference is not significant concerning group A. Fig. 6 shows that the greatest difference between groups is in V4, with a difference value between group A and B of 0.54, which means that there is a little more than half a point difference between the answers from 1 to 5 on the Likert scale. For the other items, the difference is smaller. In general, the variation between the pre-test and post-test questions has been negative, i.e., the responses have tended to move towards the value 1 (strongly disagree). The only cases in which a positive trend is observed in the post-test responses for the pre-test is in question V4 of group B and V5 of both groups, which means that the post-test responses have had a slight tendency to approach the highest values, which correspond to "agree" and "completely agree". Similarly, the variation is minimal, despite the positive trend.

The mode (Fig. 7) shows the most repeated value for each response. In questions V1, V6, and V7, the most repeated value is "strongly disagree" and no differences are found between the answers of the two groups. In V4 of Group A, although the mode is different between the pre-test ("strongly agree") and the post-test ("agree"), its values are very similar to those of group B ("agree" pre-test and post-test). The biggest difference between the pre-test and post-test fashions is found in question V2 of group B, which changes from "agree" to "disagree".

A one-way ANOVA was conducted to compare whether there were significant differences between groups based on the seven variables examined, an analysis of between-group and within-group variability was conducted. The one-way ANOVA revealed statistically significant differences in some variables. Table 3 shows the results obtained with the test of within-subjects contrasts, considering the pre-test and the

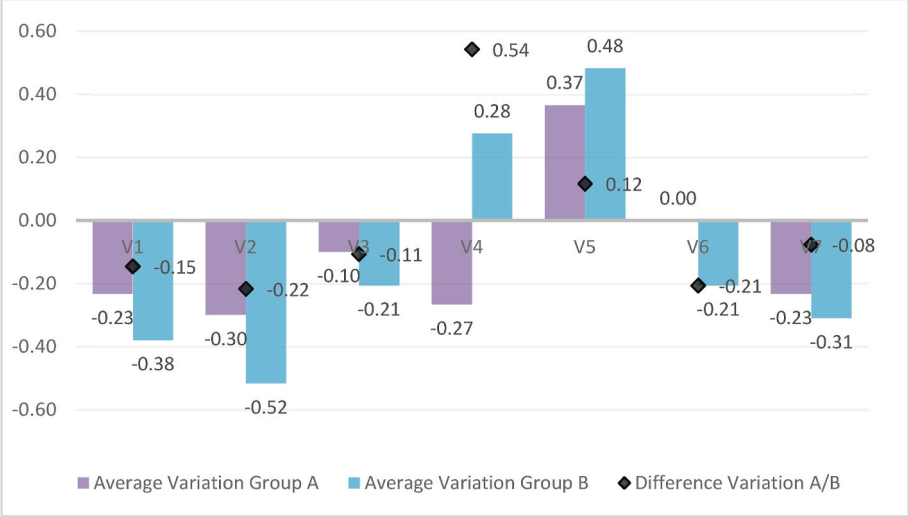


Fig. 6. Average per question of the variation between the pre-test/post-test responses of both groups.

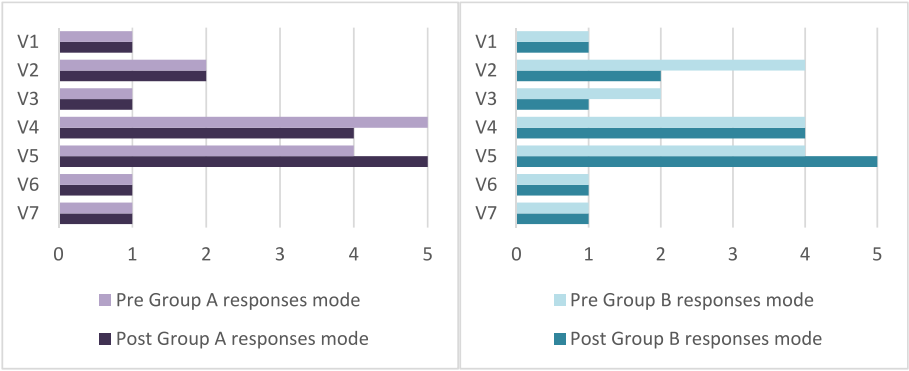


Fig. 7. Mode per pre-test/post-test question for both groups (A and B).

Table 3
Results of within-subjects contrasts test.

Variable	Type III Sums of Square	gl	Root mean square	F	Sig.
V1	3059	1	3059	5306	,025
V2	4881	1	4881	8298	,006
V3	,686	1	,686	2688	,107
V4	,000	1	,000	0,000	1000
V5	5297	1	5297	18,959	<,001
V6	,305	1	,305	1825	,182
V7	2169	1	2169	7476	,008

post-test. V1, V2, V5 and V7 show significant differences between the groups evaluated, while this is not the case for questions V3, V4 and V6. Thus, the null hypothesis in V1, V2, V5 and V7 of no significant differences is rejected.

Table 4
Tests of between-subjects effects.

Variable	Type III Sums of Square	gl	Root mean square	F	Sig.
V1	277,636	1	277,636	273,559	<,001
V2	934,102	1	934,102	479,882	<,001
V3	271,534	1	271,534	414,817	<,001
V4	0,000	1	,000	0,000	1000
V5	2144,144	1	2144,144	2026,868	<,001
V6	222,407	1	222,407	326,417	<,001
V7	305,932	1	305,932	322,222	<,001

Table 4 shows the results for the seven variables of the between-subjects effects test, considering the two treatment moments (pre-test and post-test). All variables except V4 show highly significant differences between the groups tested. The F values are high, and the significance levels are less than 0.001, indicating strong evidence of differences between subjects on all questions. For all questions except P4, the null hypothesis of no significant differences is rejected.

The iMotions analysis reveals the average values of the indicators of attention, engagement, and valence (positive, neutral, and negative) per video section (Table 5). If we compare the values of both videos (A and B) per section, we see that the average values of the variable measuring attention for video A are slightly higher. There is no difference of more than four points between the results of video B and video A in either case. It is also noted that the emotional response is very low. Although percentage differences are found between the results in sections of videos A and B, no value exceeds 5.39, which is found at the end of video B. As for the valence indicator, very high values are detected in the neutral tendency of the subjects while watching the videos. Again, the comparison between A and B shows very similar values. Regarding the positive and negative valence values, they are all very close to zero. There are therefore no striking differences between the values of videos A and B on any of the variables.

Fig. 8 identifies the results of the number of people expressing any of the emotions with the timeline (X-axis) of stimuli A (left) and B (right). The Y-axis is displayed above 6 to facilitate the visibility of the results. No remarkable data is observed since in all indicators no more than one person expresses the same emotion over the same time interval.

Table 5
Average indicator values for group A (N = 30) and group B (N = 29).

Indicator	Introduction		Increasing action		Declining action		Closing	
	A	B	A	B	A	B	A	B
Attention	99.95	98.52	99.95	98.31	99.82	98.36	99.18	96.84
Engagement	1.38	0.52	1.68	2.13	0.75	2.69	2.34	5.39
Valence (positive)	0.02	0.18	0.00	0.00	0.00	0.29	0.00	0.43
Valence (neutral)	99.79	99.47	99.60	99.12	100	98.77	98.99	96.88
Valence (negative)	0.19	0.35	0.40	0.88	0.00	0.94	1.01	2.69

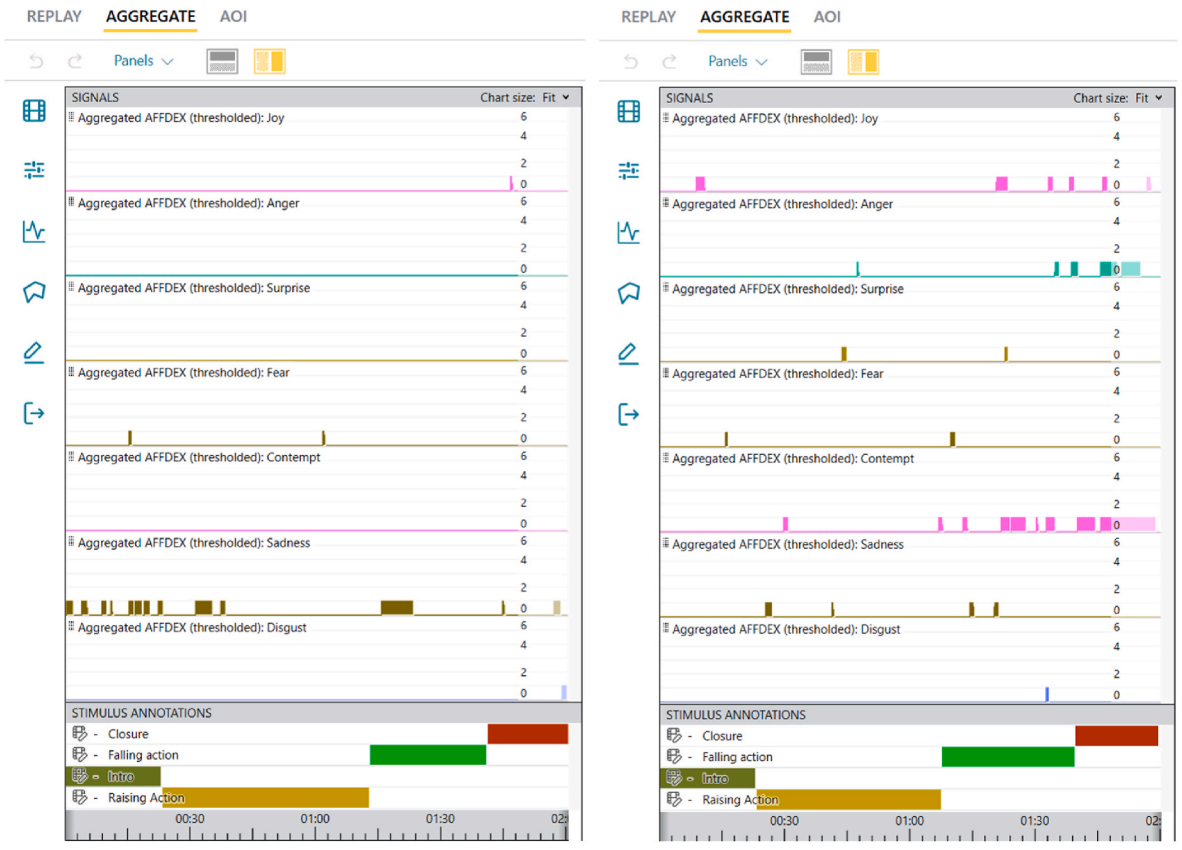


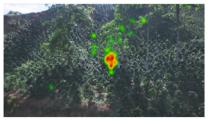
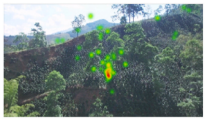
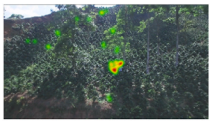
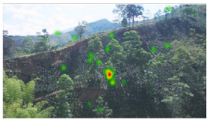
Fig. 8. iMotions analysis tool interface of group A (left) and group B (right).

Although it seems that the predominant emotions are negative (sadness, contempt), they cannot be considered due to the low number of people who expressed them along the timeline.

The results of the self-assessment question that asked the subjects to state their predominant emotion while watching the video show that emotions of a negative nature are predominant. In group A (N = 30) 16 people reported feeling surprise, 7 sadness, 6 anger or annoyance, and 1 disgust or revulsion, and in group B (N = 29) 12 people reported feeling surprise, 12 sadness, 3 anger or annoyance, 1 fear, and 1 contempt.

Regarding the analysis carried out with the information collected with *eye-tracking*, it is observed that the composition of each plane determines the attention to a specific point. There is a tendency to focus on

Table 6
Heat maps of the sequence plane at the beginning of the closure.

Video	Sequence shot		
Video A	Minute 1:42	Minute 1:46	Minute 1:50
			
Video B	Minute 1:40	Minute 1:44	Minute 1:48
			

eyes and faces, when people appear, and on objects in the foreground or focus. Table 6 shows how the trend in both videos (A and B) is similar, with the faces at the beginning of the shot being the clear centre of attention. As the plane opens towards a more general one, the dispersion of attention towards that point becomes more evident.

5. Discussion

The results obtained in the first phase of this study (SO1) show how important it is for environmental campaigns to attract attention and call to action, i.e., it is essential to reach the target audiences. This is part of the European Commission's concern (Comisión Europea, 2020) in its approach to empower citizens in their decision-making on sustainable consumption and is essential for achieving SDG 12 (United Nations, 2019, 2022). However, the results of this research also reflect the complexity of the problem and the difficulty of going beyond awareness raising to bring about real behaviour change. As Kollmuss and Agyeman (2002) point out, these findings are widely documented in studies of the attitude-behaviour consistency gap. In terms of strategies to improve effectiveness, the importance of assessing needs and expectations from a user experience perspective is raised to align messages, capabilities, and contexts of action. This approach, which underlies the research objective of this study, is related to the principles of nudge theory highlighted by Thaler and Sunstein (2008), such as default choice or heuristic availability.

The relevance of the emotional components of the message is also highlighted, emphasising that those that evoke positive emotions should be favoured over those that evoke fear or guilt. This is consistent with the findings of Berman et al. (2018) and Hamelin et al. (2020). As outlined in SO1, this affective and emotional component needs to be accompanied by calls to action that engage young people and make them feel part of the solution, not just part of the problem, by showing them ways to act responsibly. This, as Gerst et al. (2021) note, is crucial to improving the impact of these communication interventions.

The results derived from the design and evaluation of the quasi-experiment, the second phase and in relation to SO2, offer the possibility of using mixed methodological techniques to analyse the specific effects of audiovisual communication products aimed at raising environmental awareness in the context of social marketing campaigns. The recurring problem is that there is less precise knowledge about how specific aspects of narrative configuration, and the grammatical elements of the audiovisual text itself can influence the reception of the messages, and how combined analysis techniques integrating biometric sensing and neurocommunication analysis can help redefine the design of these products. This idea is in line with approaches made by Zito et al. (2021), Leeuwis et al. (2022), among others, and points to the interest in iterating the proposed model to improve the information.

6. Conclusions

This study answers the RQ satisfactorily. Although it demonstrates the potential of neurocommunication techniques in studies on the effectiveness of audiovisual products in promoting sustainable habits, the development of the second phase has shown that there is still a long way to go in this area.

The development of SO1 has enabled the identification of intermediate communication objectives that could help better target environmental awareness campaigns. Experts have expressed that generating attention-grabbing products to reach a wider audience in a first communicative approach could be a good way to promote behaviour change through concrete, simple, direct, and easy-to-understand calls to action. Furthermore, if environmental awareness campaigns can promote knowledge about the scope of the problem and provide information about the consequences of actions that citizens can take, they would help to increase the effectiveness of communication actions and products.

The insights gained from analysing expert opinion on the attributes of successful communication campaigns provide valuable information and practical implications that can affect the development of audiovisual products to assess their effectiveness. Although we have only formulated a single TH for this study, the production of further studies could lead to empirical evaluation of the attributes that increase the effectiveness and impact of audiovisual products. For example, messages that appeal to individual responsibility are more effective than those that appeal to collective responsibility when it comes to promoting sustainable habits.

The evaluated experimental model, the main outcome of this research, provides a tool to study the effectiveness of environmental awareness actions. The quasi-experimental research model (SO2) developed has great potential for studying the effectiveness of environmental awareness actions. Not only does it allow analysis of the predisposition of subjects to change their behaviour, but it also provides information on the effects of a particular stimulus on subjects, which is crucial for predicting product effectiveness. This model can improve the quality of the results of studies evaluating the effectiveness of audiovisual products and enables informed decisions to be made when designing awareness campaigns and developing communication interventions to promote behaviour change. The results of the analysis of ANOVA show that significant differences are observed when testing the instrument for most of the seven variables, leading us to conclude that the instrument is suitable for conducting research in this area, although some questions need to be adapted. The findings have practical implications for campaign planning, creative and production teams. Identifying the most influential variables of narrative discourse will help in the development of more effective audiovisual products.

In its current state, the model has the following limitations. First, the number of effects for which this model is designed. Considering that the repetition of a stimulus is a factor in the permeability of messages, the implementation of models that consider aspects of a longitudinal nature would improve studies aimed at understanding the effectiveness of products in raising environmental awareness. Secondly, it is not possible to know the reason for the effect. The inclusion of data collection methods and qualitative analyses, such as focus groups or interviews with subjects after viewing the stimulus, could improve the model by providing information about the motivations and contexts of reception that modulate the effects of the communication products used as stimuli in the experimental process.

The applicability of this model in future research is significant. It can be used to gather information about the impact of communication products and to evaluate the impact of image composition or the presentation of elements in visual compositions. Therefore, we consider two lines for future research. First, we suggest that future research should focus on improving the model by combining qualitative and quantitative data collection. Second, potential research efforts must seek to better understand what determines the effectiveness of communicative products. From an applied communication perspective, this model can be implemented to improve communicative products aimed at changing habits and thus help increase its effectiveness in promoting sustainable behaviour among youth.

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CRediT authorship contribution statement

Juan Romero-Luis: Conceptualization, Methodology, Formal analysis, Writing – original draft, Visualization, Funding acquisition. **Alejandro Carbonell-Alcocer:** Validation, Investigation, Writing – review & editing, Visualization, Funding acquisition. **Valeria Levratto:** Validation, Investigation, Data curation, Writing – review & editing. **Manuel Gertrudix:** Conceptualization, Methodology, Writing – original draft, Supervision, Project administration, Funding acquisition. **María del Carmen Gertrudis Casado:** Validation, Investigation, Writing – review & editing, Supervision. **Alexandra Hernandez-Remedios:** Investigation, Data curation, Writing – review & editing.

Declaration of competing interest

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Data availability

Data will be made available on request.

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References

Abbati, M., 2019. Communicating the Environment to Save the Planet: A Journey into Eco-Communication. Springer.
Alboan, 2019. Tecnología Libre de Conflicto. https://www.tecnologialibredeconflicto.org/.
Bauman, Z., 2013. Liquid Modernity. John Wiley & Sons.
Berman, J.Z., Barasch, A., Levine, E.E., Small, D.A., 2018. Impediments to effective altruism: the role of subjective preferences in charitable giving. Psychol. Sci. 5, 834–844. https://doi.org/10.1177/0956797617747648.
Bissing-Olson, M.J., Fielding, K.S., Iyer, A., 2016. Experiences of pride, not guilt, predict pro-environmental behavior when pro-environmental descriptive norms are more positive. J. Environ. Psychol. 145–153. https://doi.org/10.1016/j.jenvp.2016.01.001.
Blake, J., 1999. Overcoming the 'value-action gap' in environmental policy: tensions between national policy and local experience. Local Environ. 3, 257–278. https://doi.org/10.1080/13549839908725599.
Bolin, J.L., Hamilton, L.C., 2018. The News You Choose: news media preferences amplify views on climate change. Environ. Polit. 3, 455–476. https://doi.org/10.1080/09644016.2018.1423909.
Cardozo Brum, M., 2011. Las ciencias sociales y el problema de la complejidad. Argumentos 67, 15–35.
Chapman, D.A., Corner, A., Webster, R., Markowitz, E.M., 2016. Climate visuals: a mixed methods investigation of public perceptions of climate images in three countries. Global Environ. Change 172–182. https://doi.org/10.1016/j.gloenvcha.2016.10.003.
Clarke, A.E., Friese, C., 2007. Grounded theorizing using situational analysis. In: The Sage Handbook of Grounded Theory. Sage, Thousand Oaks, CA, pp. 363–397.
Clayton, S., Karazsia, B.T., 2020. Development and validation of a measure of climate change anxiety. J. Environ. Psychol., 101434 https://doi.org/10.1016/j.jenvp.2020.101434.
Clear, J., 2019. Hábitos atómicos. Cambios pequeños, resultados extraordinarios. Paidós.
Comfort, S.E., Park, Y.E., 2018. On the field of environmental communication: a systematic review of the peer-reviewed literature. Environ. Commun. 7, 862–875. https://doi.org/10.1080/17524032.2018.1514315.
Comisión Europea, 2021. NextGenerationEU. Plan de recuperación para Europa.
Comisión Europea, 2020. Nuevo Plan de acción para la economía circular. Por una Europa más limpia y más competitiva- Comunicación de la Comisión al Parlamento Europeo, al Consejo, al Comité económico y social europeo y al Comité de las regiones. https://bit.ly/3yiFcKF.
Comisión Europea, 2019. Un Pacto Verde Europeo. Esforzarnos por ser el primer continente climáticamente neutro. https://bit.ly/3oxep92.
Corbin, J.M., Strauss, A., 2008. Basics of Qualitative Research. SAGE Publications Inc, Los Angeles.
de Morais, L., Lopes, Herminio, Pinto, D.C., Cruz-Jesus, F., 2021. Circular economy engagement: altruism, status, and cultural orientation as drivers for sustainable consumption. Sustain. Prod. Consum. 523–533. https://doi.org/10.1016/j.spc.2021.01.019.
Domegan, C., 2021. Social Marketing and Behavioural Change in a Systems Setting. Current Opinion in Environmental Science & Health, 100275. https://doi.org/10.1016/j.coesh.2021.100275.
Ebrahim, A., Rangan, V.K., 2014. What impact? A framework for measuring the scale and scope of social performance. Calif. Manag. Rev. 3, 118–141. https://doi.org/10.1525/cmr.2014.56.3.11.
Ekman, P., Friesen, W.V., 1978. Facial Action Coding System. Consulting Psychologists Press, Palo Alto, CA, USA.
Escobar-Pérez, J., Martínez, A., 2008. Validez de contenido y juicio de expertos: una aproximación a su utilización. Avances en Medición 27–36.
Farnsworth, B., 2022. Facial Action Coding System (FACS) – A Visual Guidebook. http://bit.ly/41SeDJV. (Accessed 13 December 2022).
Febles, M., 2001. Hacia un enfoque holístico del Medio Ambiente desde la Psicología Ambiental. Facultad de Psicología. Universidad de la Habana.
Ferrés Prats, J., 2014. Las Pantallas Y El Cerebro Emocional. Gedisa, Barcelona.
Fischer, D., Selm, H., Sundermann, A., Storksdiec, M., 2020. Storytelling for sustainability A definition and its implications for education and communication. In: Molthan-Hill, P., Luna, H., Wall, Tony, Puntha, H., Baden, D. (Eds.), Storytelling for Sustainability in Higher Education. Routledge.
Fleiss, J.L., Levin, B., Paik, M.C., 2003. Statistical Methods for Rates and Proportions, 3 ed. Wiley, Hoboken, NJ.
Flick, U., 2018. In: Designing Qualitative Research, second ed. SAGE publictions Ltd, London.
Freytag, G., 1894. Technique of the Drama: an Exposition of Dramatic Composition and Art. S.C. Griggs.
García Marzá, D., Fernández Beltrán, F., Sanahuja, R., Andrés, A., 2018. El diálogo entre ciencia y sociedad en España. Experiencias y propuestas para avanzar hacia la investigación y la innovación responsables desde la comunicación. Servei de Comunicació i Publicacions. Universtat Jaume I, Castelló de la Plana.
García, E., 2018. La transición ecológica: definición y trayectorias complejas. Ambienta 125, 86–100.
García-Castillo, N., Bueno-Doral, T., Hänninen, L., 2020. Responsible research and innovation (RRI) as a driving force for change in corporate communication: new forms of governance and participatory structures. El Prof. Inf. 3, e290313 https://doi.org/10.3145/epi.2020.may.13.
Gerst, M.D., Kenney, M.A., Feygina, I., 2021. Improving the usability of climate indicator visualizations through diagnostic design principles. Clim. Change 3, 33. https://doi.org/10.1007/s10584-021-03109-w.
Green, K.M., Crawford, B.A., Williamson, K.A., DeWan, A.A., 2019. A meta-analysis of social marketing campaigns to improve global conservation outcomes. Soc. Market. Q. 1, 69–87. https://doi.org/10.1177/1524500418824258.
Groening, C., Sarkis, J., Zhu, Q., 2018. Green marketing consumer-level theory review: a compendium of applied theories and further research directions. J. Clean. Prod. 1848–1866. https://doi.org/10.1016/j.jclepro.2017.12.002.
Gruen, D., Rauch, T., Redpath, S., Ruettinger, S., 2002. The use of stories in user experience design. Int. J. Hum. Comput. Interact. 3–4, 503–534. https://doi.org/10.1080/10447318.2002.9669132.
Guldborg Hansen, P., Maaløe Jespersen, A., 2013. Nudge and the manipulation of choice. A framework for the responsible use of the nudge approach to behaviour change in public policy. European Journal of Risk Regulation 1, 3–28. https://doi.org/10.1017/S1867299X00002762.
Hamelin, N., Thaichon, P., Abraham, C., Driver, N., Lipscombe, J., Pillai, J., 2020. Storytelling, the scale of persuasion and retention: a neuromarketing approach. J. Retailing Consum. Serv., 102099 https://doi.org/10.1016/j.jretconser.2020.102099.
Heras, F., 2009. Los efectos rebote y otros efectos secundarios de los programas para mitigar el cambio climático: una mirada desde la educación y la comunicación. In: Heras, F., Sintes, M., Serantes, A., Campos, V., Valdes, C. (Eds.), Educación Ambiental Y Cambio Climático. CELDA, pp. 277–289.
Ho, D.T.K., Intai, R., 2017. Effectiveness of audio-visual aids in teaching lower secondary science in a rural secondary school. Asia Pac. J. Educ. Educ. 91–106.
Holland, A., 2019. Don't Change the Goal, Change the (Communications) Plan: Improving How We Communicate about Climate Change. http://bit.ly/3yhGwxh.
iMotions, 2022. Galvanic Skin Response: the Complete Pocket Guide. https://imotions.com/guides.
International Chamber of Commerce, 2018. ICC Advertising and Marketing Communications Code. https://bit.ly/41QdWAQ.
IPCC, 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. The Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg2/.

Jones, M.D., Peterson, H., 2017. Narrative persuasion and storytelling as climate communication strategies. In: Nisbet, M.C., Ho, S.S., Markowitz, E., O'Neill, S., Schäfer, M.S., Thaker, J. (Eds.), The Oxford Encyclopedia of Climate Change Communication. Oxford University Press.

Kapoor, P.S., Balaji, M.S., Jiang, Y., 2021. Effectiveness of sustainability communication on social media: role of message appeal and message source. Int. J. Contemp. Hospit. Manag. 3, 949–972. https://doi.org/10.1108/IJCHM-09-2020-0974.

Kerret, D., Orkibi, H., Ronen, T., 2016. Testing a model linking environmental hope and self-control with students' positive emotions and environmental behavior. J. Environ. Educ. 4, 307–317. https://doi.org/10.1080/00958964.2016.1182886.

Kidd, L.R., Garrard, G.E., Bekessy, S.A., Mills, M., Camilleri, A.R., Fidler, F., Fielding, K. S., Gordon, A., Gregg, E.A., Kusmanoff, A.M., Louis, W., Moon, K., Robinson, J.A., Selinske, M.J., Shanahan, D., Adams, V.M., 2019. Messaging matters: a systematic review of the conservation messaging literature. Biol. Conserv. 92–99. https://doi.org/10.1016/j.biocon.2019.05.020.

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.

Kollmuss, A., Agyeman, J., 2002. Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ. Educ. Res. 3, 239–260. https://doi.org/10.1080/13504620220145401.

Lavrakas, P., 2008. Encyclopedia of Survey Research Methods. SAGE, Thousand Oaks, California.

Lee, N.R., Kotler, P., 2019. Social Marketing: Behavior Change for Social Good. Sage Publications.

Leeuwis, N., van Bommel, T., Alimardani, M., 2022. A framework for application of consumer neuroscience in pro-environmental behavior change interventions. Front. Hum. Neurosci. https://doi.org/10.3389/fnhum.2022.886600.

Lukinović, M., Jovanović, L., 2019. Greenwashing – Fake Green/environmental Marketing. Farplss. https://doi.org/10.33531/farplss.2019.3.04.

Martínez León, P., Ballester Roca, J., Ibarra Rius, N., 2018. Estudio cuasiexperimental para el análisis del pensamiento crítico en secundaria. REDIE. Revista electrónica de investigación educativa. https://doi.org/10.24320/redie.2018.20.4.1705.

Mefalopulos, P., 2005. Communication for sustainable development: applications and challenges. Media and glocal change.Rethinking communication for development 247–260.

Muller, P., Fontrodona, J., 2020. Medición del impacto social: bases para un marco común de diálogo. Cuadernos de la Cátedra CaixaBank de Responsabilidad Social Corporativa 46.

O'Rourke, D., Lollo, N., 2015. Transforming consumption: from decoupling, to behavior change, to system changes for sustainable consumption. Annu. Rev. Environ. Resour. 1, 233–259. https://doi.org/10.1146/annurev-environ-102014-021224.

Pérez de Albéniz Garrote, G., Rubio, L., Medina Gómez, B., Buedo-Guirado, C., 2021. Smartphone abuse amongst adolescents: the role of impulsivity and sensation seeking. Front. Psychol. https://doi.org/10.3389/fpsyg.2021.746626.

Rejeb, A., Rejeb, K., Keogh, J.G., 2022. The circular economy and marketing: a literature review. Etikonomi 1, 153–176. https://doi.org/10.15408/etk.v21i1.22216.

Rizzi, F., Annunziata, E., Contini, M., Frey, M., 2020. On the effect of exposure to information and self-benefit appeals on consumer's intention to perform pro-environmental behaviours: a focus on energy conservation behaviours. J. Clean. Prod., 122039 https://doi.org/10.1016/j.jclepro.2020.122039.

Rizzolatti, G., Craighero, L., 2004. The mirror-neuron system. Annu. Rev. Neurosci. 169–192. https://doi.org/10.1146/annurev.neuro.27.070203.144230.

Rodrigo-Cano, D., Picó, M.J., Dimuro, G., 2019. Los Objetivos de Desarrollo Sostenible como marco para la acción y la intervención social y ambiental. RETOS.Revista de Ciencias de la Administración y Economía. 17, 25. https://doi.org/10.17163/ret.n17.2019.02.

Rodríguez, A., 1991. Psicología Social. Trillas, México.

Romero-Luis, J., Carbonell-Alcocer, A., Gertrudix, M., Gertrudis Casado, M.d.C., Giardullo, P., Wuebben, D., 2022. Guía instrumental de la recogida de información para la Teoría Fundamentada. https://zenodo.org/record/6806925.

Sánchez-Gutiérrez, J.L., 2000. Sociedad, política, cultura y sistemas complejos. Ciencias 59, 46–54.

Servaes, J., Lie, R., 2015. New challenges for communication for sustainable development and social change: a review essay. J. Multicult. Discourses 1, 124–148. https://doi.org/10.1080/17447143.2014.982655.

Spash, C.L., Dobernig, K., 2017. Theories of (Un)Sustainable consumption. In: Spash, C.L. (Ed.), Routledge Handbook of Ecological Economics. Routledge.

Taufique, K.M.R., Siwar, C., Chamhuri, N., Sarah, F.H., 2016. Integrating general environmental knowledge and eco-label knowledge in understanding ecologically conscious consumer behavior. Procedia economics and finance. In: The Fifth International Conference on Marketing and Retailing (5th INCOMaR) 2015, pp. 39–45. https://doi.org/10.1016/S2212-5671(16)30090-9.

Thaler, R., Sunstein, C.R., 2008. Nudge: Improving Decisions about Health, Wealth, and Happiness. Yale University Press.

Truong, V.D., Dong, X.D., Saunders, S.G., Pham, Q., Nguyen, H., Tran, N.A., 2021. Measuring, evaluating, and documenting social marketing impact. J. Soc. Market. 3, 259–277. https://doi.org/10.1108/JSOCM-11-2020-0224.

United Nations, 2022. Informe provisional sobre el marco decenal de programas sobre modalidades de consumo y producción sostenibles. http://bit.ly/3F5qM4l.

United Nations, 2019. ODS 12. Garantizar modalidades de consumo y producción sostenibles. https://sdgs.un.org/es/goals/goal12.

Yoon, M., Yun, H., 2021. Relationships between adolescent smartphone usage patterns, achievement goals, and academic achievement. Asia Pac. Educ. Rev. https://doi.org/10.1007/2Fs12564-021-09718-5.

Zambrano Díaz, A.O., 2017. Diseño y validación de un cuestionario para el docente: análisis de sus propiedades psicométricas. Revista INTEREDU 7, 27–46.

Zito, M., Fici, A., Bilucaglia, M., Ambrogetti, F.S., Russo, V., 2021. Assessing the emotional response in social communication: the role of neuromarketing. Front. Psychol. https://doi.org/10.3389/fpsyg.2021.625570.