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Does Ecotourism Influence Environmental Awareness? A Methodological Approach Based on Virtual Reality and Physiological Responses

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ABSTRACT

More than 16,000 Scholars assert that engagement in nature-based activities is a critical approach to help modern society transform its contemporary culture into a sustainable one. This connection, however, has not been scientifically proven, because so far the methods applied relied on questioning and observing tourists involved in ecotourism activities, hence research samples were small and biased. This work presents an alternative methodological approach for exploring this influence with larger and less biased samples, while understanding how and why memorable experiences are evaluated and appreciated. It uses immersive virtual reality, mobile electroencephalograph, electro-dermal activity sensors, mobile eye tracker devices, a camera / software of facial expressions recognition, questionnaires and Bayesian Belief Networks. This methodological approach was built based on a multidisciplinary approach. It learnt from the tourism literature that the level of influence of nature-based activities on the way tourists relate with nature depends: on the experience (stimuli) and on tourists' profile (gender, age and socio-cultural background), previous level of environmental awareness, previously lived similar experiences (level of novelty) and motivations to enrol on the experience. Based on these learnings, this study proposes a methodology that uses non-voluntary reactions to assess the level of influence of nature-based activities on the way tourists relate with nature. To do so, this method compares tourists' non-voluntary reactions (brain waves, skin conductance, facial expressions and focus) to different simulated tourism experiences and how these affect the recall of the experiences.

Keywords: *ecotourism; neuroscience; methodology.*

INTRODUCTION

More than 16,000 scholars have asserted that engagement in nature-based leisure activities, such as ecotourism, is critical to assist the transformation of contemporary culture into one that is sustainable (Ripple et al., 2017). This is because engagement helps to strengthen the link between urban people and nature (Louv, 2010) and, in doing so, enhances "awareness towards the conservation of natural and cultural assets" (WTO, 2018).

Many scholars have attempted to demonstrate this influence (e.g. Schanel and Holer, 1990, Moscardo, 2005, Lyons and Breakwell, 2004). A systematic literature review using Scopus indicates that, during the last decade (i.e. 2009 – 2019), thirty-four peer-reviewed papers specifically focused on analysing this influence. Despite the effort, few correlations have been found (Reynolds and Braithwaite, 2001, Moscardo, 2005, Apps et al., 2018). As results have been largely inconclusive, the real impact of engaging in nature-based leisure and ecotourism activities on tourists' eco-awareness remains unclear (Fennell, 2001, Jones, 2000, Moscardo, 1999, Moscardo, 2005, Tubb, 2003, Uysal, 1994, Powell and Ham, 2008).

We posit that the inconclusiveness of this body of knowledge is due mainly to the constraints present within methods commonly used in tourism research. This paper presents a method that seeks to address these constraints by proposing the use of technologies that identify physiological response to nature-based stimuli towards clarifying how, why and if ecotourism

activities influence tourist eco-awareness and motivation to support conservation.

Existing studies that focus on understanding the influence of ecotourism on tourist eco-awareness (i.e. consideration of ecological and sustainability matters) are based on real experiences (either memories of past experiences or experiences taking place when the research is conducted) using interviews and observation (Ballantyne et al., 2011). Of the 34 peer-reviewed papers identified from the systematic literature review, 33 used as the main methods: interviews (surveys or questionnaires) and observation (one analysed newspaper articles). These approaches: (1) limit and (2) potentially bias samples, by weight of participant numbers, towards people who were already eco-friendly before the tourism experience; (3) skew research questions, answers and analyses; and (4) limit results to whether change in attitude is perceived, though these do not help understanding of how the change process has occurred.

Difficulty1. Limited Samples

In the industrialised world, quality control systems mean that two consumers buying the same product tend to receive almost identical items. As examples, a can of Coca-Cola or a hamburger from MacDonald's are likely to have the same ingredients and flavours around in the world. Hence, a researcher may interview large numbers of consumers if they want to discover, for example, what consumers feel when they consume a specific product. The product becomes an independent variable. This approach is valid, because all consumers are exposed to the same physical product, even when they consume the product in different places or at different times (see Denzin and Lincoln, 2011, Denzin and Lincoln, 2003, Denzin and Lincoln, 1994).

In comparison, tourism presents unique 'products/services'; therefore, two tourists paying for the same 'product/service' may have different experiences. Two tourists on the same tour boat, for example, may have different experiences as one tourist may sight a whale, while another may not see anything, being seated on the opposite side of the boat. The next tour might not see whales at all, and a third boat might be followed by dolphins. One group might enjoy perfect weather conditions, while others may experience strong winds and large waves. Thus, experiences are at best inconsistent. Because each tourism experience is unique, the number of people exposed to the same experience tends to be few. This limits the number of possible research subjects, and where research participants advise their response to an ecotourism experience, their feelings may have been shaped by different environmental variables as well as different interpretations of that environment.

Difficulty2. Biased Samples

If a researcher investigating how people feel when they consume soft drinks or food produced by retail chains selects mostly respondents who are attentive to a healthy life style, for example, results are likely to be biased toward predispositions that associate these foodstuffs negatively (see Connell and Mayor, 2013). Similarly, if sample respondents are not diet-conscious or do not like to exercise, results may be biased towards more positive feelings about the food types. Consequently, a large sample size would be needed to permit statistical separation of the two types of respondents.

This often applies to social research, so a study that focuses on understanding the impact of ecotourism on tourist eco-awareness needs to have a sample with similar proportions of people who care and do not care as much about conservation, across variables such as age, gender and nationality. This would then provide a heterogenous sample for hypothesis testing of links between pro-environmental behaviours and ecotourism experiences (and the demographic variables). However, obtaining an equal representation of age, gender and nationality remains difficult due to the limited number of people undertaking the same or similar ecotourism experiences. Adding the variable of those respondents who care and do not care about conservation exacerbates the sampling problem, because people who do not value nature and conservation are less likely to get involved in ecotourism experiences (Sarkar et al., 2015, Głąbiński, 2015). Therefore, if the research uses a sample of tourists who are or have been involved in ecotourism experiences, then it is likely the sample is biased towards people who were eco-friendly before the tourism experience.

Difficulty3. Biased Research Questions, Answers and Analyses

Science is never unbiased (Hull, 1990, Brightman, 1939, Ihde, 2002), because personal

attributes define the problems that are studied, the methods and technologies that are applied and, in the case of social sciences, the moral values from where the observer and the observed are situated within the research (Bauman, 1998, Sinay, 2008). Therefore, a researcher who wants to defend the consumption of soft drinks and food produced by retail chains may ask informants if they have positive feelings just after drinking and eating the products, while a researcher with a predisposition against the consumption of these products may ask how informants feel after the food has been digested. The responses are likely to be different, even for the same individual. The same applies to ecotourism studies (Park and Santos, 2016). Answers to questions asked just after viewing a whale breaching are likely to be different to answers given after the boat returns to shore, especially if the tourist is tired or seasick. Other factors are masking the response to the stimulus.

Studies that involve post-event reporting of participant reflection and memory recall are invariably unreliable (Dubé& Morgan, 1996; 1998).Respondents may censure responses to be socially or politically correct to avoid being perceived as unethical or morally wrong, and may even regulate responses to conform with the tenor of the issue being investigated and the perceived perspective of the enumerator. For example, if the interview takes place on a whale-watch boat, it is less likely tourists would support the capture of whales for the purposes of entertainment in theme parks (e.g. an aquarium), despite having never thought about what is involved in the 'whale-park' industry. Also confounding the reliability of human response to stimuli studies is the influence of external factors such as the opinions of companion tourists, the tendency to over-estimate emotions in self-reported measures (Li et al., 2017) and the difficulty in recalling specific emotional responses in time and situational contexts (Dubé& Morgan, 1996; 1998).

Difficulty4. Descriptive Nature of Existing Studies

Common in surveys of the influence of ecotourism experiences on tourist eco-awareness are questions that seek self-assessment of a change in environmental friendliness because of the experience. Even assuming unbiased reporting, there is no ability to identify specific elements of the experience or the internal transformation process that created the change. Tourists find it difficult to accurately recall and articulate their internal psychological processes fully (Dubé& Morgan, 1996; 1998). So, even when the researcher manages to get through limited and leading samples, questions, observations and answers, there remains a limit to retrieving subliminal decisions or attitudes about whether ecotourism experiences influence awareness related to the conservation of nature.

Virtual Reality for Research

In this context, the new methodological approach for discovering how, why and if ecotourism activities influence tourist eco-awareness needs to create mechanisms that allow for a larger and more balanced sample; neutralise (as much as possible) the researcher's and the participants' perceptions; and explain the process of change in awareness.

As the use of real ecotourism experiences can potentially limit and bias research samples and responses, it would be advantageous to seek a standardised, repeatable experience. Simulated experiences (e.g. virtual reality) have the potential to provide this, and have already been used in studies of tourism products (Guttentag, 2010). Virtual reality (VR) allows "individuals to see, hear, and feel digital stimuli as if they were in the physical world" (Ahn, Bailenson, & Park, 2014). Virtual reality is already in use both in the composition of tourism products (2018) and on tourism research (Guttentag, 2010).

It does lack sensory stimulations such as smells and touch. However, VR seems to able to expand the possibilities of research within the tourism field, among others. VR adoption as a tourism product and as a research tool had shown to generate powerful emotions and stimulate senses (Water worth et al 2001) while potentially providing a mechanism to deliver knowledge and information and to promote focus, attention, engagement and motivation (Chung et al. in press; Lee, Chen & Su, 2017; Tussyadiah, Jung & tom Dieck in press).

To explore the influence of ecotourism on tourist eco-awareness, VR can be used to reproduce ecotourism experiences, such as whale watching and safaris. As the experience would take place in an image lab, informants can be selected so that the level of eco-

awareness, gender, age and other cultural and demographic variables are represented across the sample. Also, the experiment can be replicated across time and space, hence the number of participants can be defined by the researcher.

METHODOLOGY

If the types of questions and the moments sought to be recalled, as well as the world views of the researcher and participants have the potential to skew results, then it would be ideal to substitute them with approaches that monitor tourists' real-time reactions to a simulated ecotourism experience. One way to do this is to monitor the real time physiological reaction to the experience.

Previous physiological studies indicate that stimuli are perceived by receptors (e.g. eyes), which convert stimuli into electrical nerve impulses that navigate through the brain (brain waves) and skin (electro-dermal activity) to the central nervous system where a response, such as an emotion, may be produced. Such features (brain waves, skin conductance, eye movements and emotion/facial expressions) indicate arousal (Wang & Sparks, 2016), fixation (Rainoldi, Neuhofer, &Jooss, 2018), and emotions (Ismail, Hanif, Mohamed, Hamzah, &Rizman, 2016), which are non-subjective indicators of a person's interaction with the surroundings.

The sort of interaction or response depends on:

- The attention span of the receptor (e.g. cognitive processes occur when eyes fixate on stimuli for more than three seconds (Rainoldi, Neuhofer, &Jooss, 2018);
- The brain-wave frequency produced by the stimuli (Ismail, Hanif, Mohamed, Hamzah, &Rizman, 2016) (e.g. a stimulus that causes Beta or Gama frequencies is more likely to generate concentration and learning than stimuli that causes Delta and Theta frequencies, which usually indicate sleep and deep relaxation states (Pan, Zhang & Smith, 2011; Wang & Sparks, 2016); and
- The emotions elicited from the stimuli (Ismail, Hanif, Mohamed, Hamzah, &Rizman, 2016).

Therefore, physiological responses can be used as a proxy for the emotional response during an ecotourism experience to ascertain the influence on a tourist (Wang & Sparks, 2016). These responses can be monitored during the simulated experience with the use of:

- Mobile electroencephalograph (EEG), which records brain activity (voltage fluctuations);
- Electro-dermal activity sensors (EDA), which monitor skin conductance;
- Mobile eye tracker devices, which film what is causing the stimulus; and

Facial expression recognition, which consists of a camera and software that interprets emotions.

A MODEL TO EXPLAIN THE ECOTOURISM INFLUENCE PROCESS

Models, which are simplified abstractions of reality, are frequently used to explain how a particular phenomenon comes about, enabling it to be visualised and comprehended (Sinay, 2008). They are a bridge between a conceptual problem and its understanding, hence can be used to explain how ecotourism influence occurs or not.

Based on previous research, the hypotheses for building a model for this research are as follows.

- The level of influence of nature-based activities on the way tourists relate to nature depends on: the experience (stimuli) and the tourists' demographic profile (e.g. gender, age and socio-cultural background), previous level of environmental awareness, previous experiences with related stimuli (level of novelty), and motivations to voluntarily engage in the experience (Schanel and Holer, 1990, Lyons and Breakwell, 2004, Wang and Sparks, 2016, Kals et al., Reynolds and Braithwaite, 2001).
- Physiological information, such as brain waves, eye movements, pupil dilation, facial expressions and skin conductance, indicate arousal (i.e. level of physical and mental alertness) (Wang & Sparks, 2016), fixation (i.e. focus of eye movement to a certain area of the visual field) (Rainoldi, Neuhofer, &Jooss, 2018) and emotions (i.e. communication of reactions of the body) (Ismail, Hanif, Mohamed, Hamzah, &Rizman, 2016), which are non-subjective indicators of a person's interaction with surroundings. Hence, they can be used as a proxy for an ecotourism experience and its influence on a tourist (Wang & Sparks, 2016).
- The intensity of involuntary responses (e.g. brain waves, skin conductance and eye fixation) to a stimulus affects recall. Recall is a proxy for articulation of knowledge. Knowledge affects beliefs; therefore,

commitments and intentions to act. If an individual has an intense conservation-related experience, then there may be reason to link response to recall, then articulation of knowledge, then intended behaviour (Figure I).

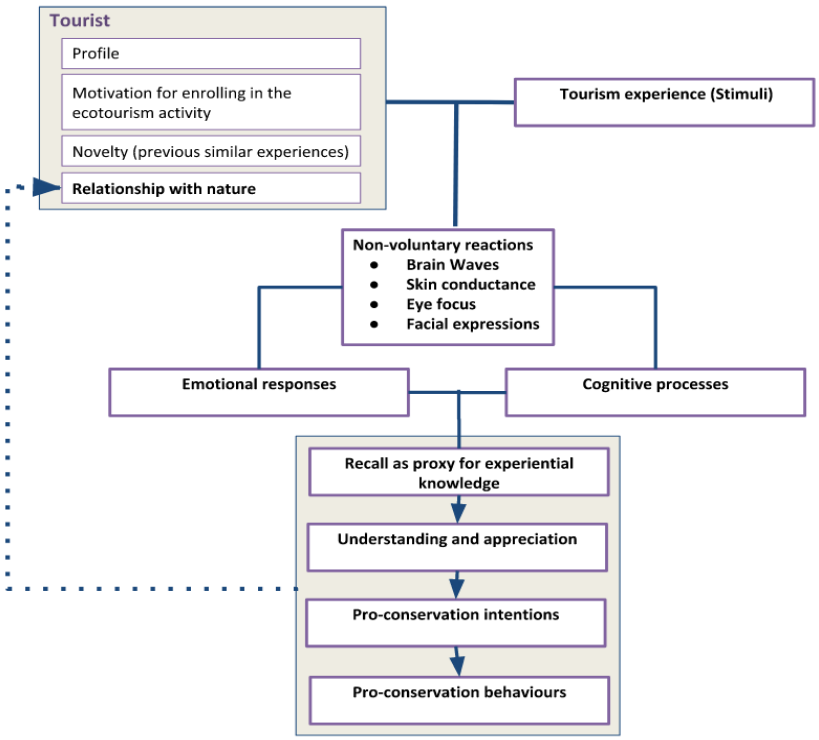

Figure I. *Asserted links between experience and conservation behaviours*

While the proposed model can aid in understanding the process, it needs to be populated with real data to validate its links and the relative impact of the different incorporated elements. Bayesian belief networks (BBNs), which are a probabilistic approach used to represent the complexity of systems through cause and effect relationships (Cain, 2001; Nadkarni and Shenoy, 2004), can be built based on the opinion of experts or using empirical data (Cain, 2001). Bayesian logic is ideal for modelling uncertain systems and situations where data are missing (Morgan, 1968; Winkler, 1972; Gardenfors and Sahlin, 1988; Carlin and Louis, 1996; Jensen, 2001; Ames, 2002; Gill, 2002; Haeussler et al., 2005; Cain, 2001; Nadkarni and Shenoy, 2004). BBNs use tables to assess the probable outcome of events (Sinay, 2008). Hence, they can be useful for exploring the relative impact of the different components of the model.

Application to Measure Influence of Ecotourism on Tourist Eco-Awareness

Methodologies are strategies designed to achieve desired outcomes (Sinay, 2008), being step-by-step procedures that, in this case, can be used to deepen the understanding of how ecotourism experiences influence tourist eco-awareness.

Step1. Develop the Simulated Experience

The first task involves developing the simulated experience, which starts with the choice of the ecotourism or nature-based activity to be simulated. While it can reflect any activity, it needs to simulate reality, as one would expect to see on a tour, not in a documentary, otherwise, the methodology would be testing the impact of documentary not of ecotourism activities. Table 3 presents two examples of how to structure simulated experiences. Key points to be noted are: the necessity to have stimuli-absent times in the beginning and between stimuli so that initial levels of excitement are neutralised; the whole simulated experience is no longer than five minutes to reduce participant fatigue or nausea, and the complexity of data analysis.

Step2. Define the Sample Size

As a BBN will be used to test the links of the model and the relative importance of the elements considered, the number of participants can be defined by the requirements of the BBN. In this case, the elements that determine the

sample size are the ones included in the 'Tourist' box (Figure 1) (i.e. profile, motivation for participating in the ecotourism activity, novelty and relationship with nature). For the sake of this explanation, the element 'profile' is subdivided into three nodes: gender, age and nationality, and each of the six nodes has three possible states. Based on this scenario, to test one participant with each possible profile would require 729 participants (i.e. 3^6). Yet, as BBNs work well with uncertainty, approximately 10 per cent of this number would be the minimum requirement (i.e. 73 volunteers) (see Sinay 2008).

Step3. Inviting Participants

To avoid biased samples, attention needs to be given to how research participants are approached. If, for example, they are invited to participate on an ecotourism simulated experience, it is likely that the sample will be biased towards people who have interest in ecotourism activities. Therefore, different rounds of invitation should take place. In each, different information can be provided (e.g. participants are informed that volunteers are being sought to take part in research on whale tourism or participating in testing neuroscience equipment to explore people's physiological reactions to simulated experiences). Specific information about the sort of experience should only be disclosed after the volunteer has contacted the research group regarding their expression of interest.

Step4. Selecting Participants

The profile of participants should be as diverse as possible. However, as it will not be possible to know beforehand volunteers' motivation, level of novelty or relationship with nature, volunteers should be selected based on attracting equal numbers of participants based on demographic variables (e.g. gender, age and place of residence).

Step5. The Experience

When a participant arrives at the laboratory, the researcher should proceed to describe how the experience will follow. Then, the equipment should be attached (the camera is a priory so that the face of the volunteer can be filmed), possibly at the same time as conducting a pre-experience interview to collect information about the volunteer:

- Profile: age, gender and place of residency;
- Motivation for enrolling in the experience: which is the motivation and level of motivation (01 to 05);
- Novelty (previous similar experiences): how many times the person participated in whale-watching activities and description of experiences; and
- Relationship with nature: self-report level of environmental awareness (01 to 05) and explanation of the self-evaluation.

This interview will give time for the volunteers to get used to the equipment. At the end, if no malaises are felt by the volunteer, the simulated experience can start.

Step7. The Noticed Influence

Three follow up questionnaires should be applied: just after the experience, and 15 and 90 days after the experience. Questionnaires should focus on asking volunteers to:

- Describe the images in the order they remember; and
- Describe why they are memorable and what they felt.

Step8. Data Analysis

Data collected with EEG and EDA can be analysed (with BIOPAC AcqKnowledge® 4 Software) to identify an individuals' brain reactions to the presented stimuli (i.e. minimum, maximum and time lapse of oscillations of voltaic fluctuations). Analysis of data (with Software Imotions) collected with mobile eye trackers will result in heat maps, which indicate individual and group focus and time lapse of attention. Software Imotionscan also be used to analyse emotional responses. These are interpreted as fleeting and transitory emotional expressions that typically last from half a second to four seconds and that communicate how and what people feel (Ahn et al., 2010). Statistics will be used to analyse data collected by questionnaires.

The collected data can be used to estimate: participants' profile, intensity of reactions to each stimulus (IR), time lapse of reactions (T) and of focus (F), and emotions (ER). summarises how each instrument of data collection can be used, what would be measured and how variables can be estimated.

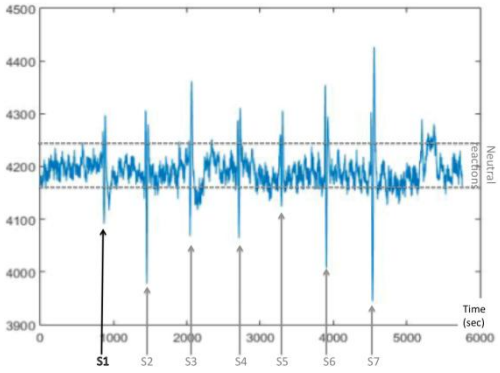

Figure2. *Example of EEG's results – adapted from (Nacy et al., 2016)Y-axis represents voltage fluctuations on the motor cortex caused by seven stimuli (S1 to S7a). X-axis indicates real time of EEG recording.*

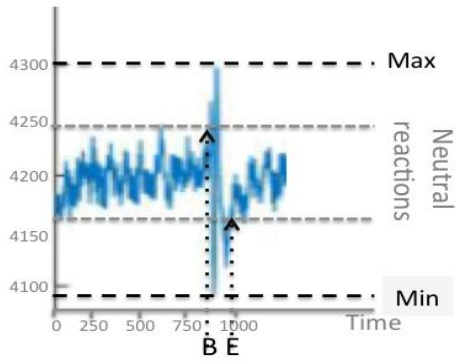

Figure3. *Zoom on S1Doted horizontal grey lines represent electrical activity under the influence of no stimuli. Doted horizontal black lines indicate minimum and maximum levels of electrical activity caused by S1. Doted black vertical lines mark the begging (B) and the end (E) of the brain reaction to S1.*

Statistics and probability will be used for conditioning links between stimuli, volunteers' profile, intensity of reactions or voltage fluctuation (IR), focus lapse (F), emotional reactions (SR) and recall of stimuli (for details about these analyses).

BBNs will be used for the probabilistic analysis (II). Their nodes and links are derived from extant literature (e.g. Van Liere& Dunlap, 1980; Schanel & Holer, 1990; Reynolds & Braithwaite, 2001; Lyons &Breakwell, 2004; Tse&Crotts, 2005; Menéndez, 2005; Jang & Feng, 2007; Assaker, Vinzi& O'Connor, 2011; Cheng & Lu, 2013; Robson, 2014; Rainoldi, Neuhofer, &Jooss, 2018), and probabilities will be based on involuntary reactions (Table 8).

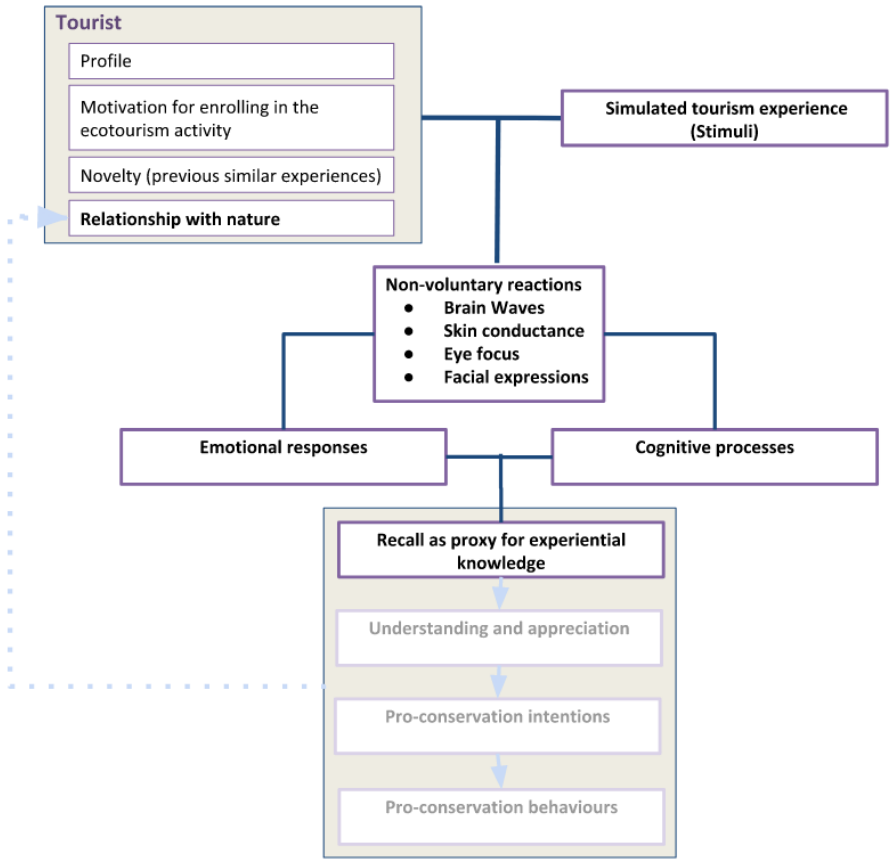

Figure II: *Framework for BBN*

Tourists' profile and tourism stimuli influence non-voluntary responses that regulate post effects. Factors on grey are not analysed in this experiment

CONCLUSION

This paper provided an overview of contemporary research methods used to investigate one of the core questions of ecotourism studies (i.e. if ecotourism activities influence tourists' levels of eco-awareness), and concluded that a methodology is required to generate unbiased and larger samples, as well as less skewed research designs. Based on this, we advocate for the adoption of simulated experiences to address biased samples, by employing neuroscientific tools to monitor tourists' physiological reactions and BBNs to analyse the collected data.

The method here proposed can help on advancing the scientific understanding of the tourism phenomena, as it allows comprehending the process by which ecotourism activities influence people's feelings, emotions and attitudes. This understanding can be used to improve existing ecotourism theories and definition.

Better understanding of the tourism phenomena is important not only for academic purposes, but also for improving tours and management of protected areas and wildlife. In this regard, if no evidence is found about the relationship between ecotourism activities and tourists' environmental awareness, then this knowledge may be used to restrict tourism activities that disturb wildlife. Or, if the method helps on proving that ecotourism activities in fact improve tourists' environmental awareness, then the proposed method may allow discovering the optimal length of contact and distance to wildlife, and the sort of activities that can take place when and if the main objective is improving tourists' environmental awareness.

If a positive relationship is confirmed (i.e. ecotourism activities influence environmental awareness) then further research can use the same method to improve the understanding of the impact of documentaries and can help on improving their related influence. This can be used for educational purposes.

In conclusion, the proposed method can help improving the theory, the definition and the practice of ecotourism, which, in turn, can intensify its influence on the transformation of contemporary culture into one that is sustainable.

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