The Stress Reduction Effect of Nature Through Virtual Reality (VR): a Systematic Review Protocol

Ambra Gentile (ambra.gentile01@unipa.it)  
University of Palermo: Universita degli Studi di Palermo  
https://orcid.org/0000-0001-5301-7023

Antonino Bianco  
University of Palermo: Universita degli Studi di Palermo

Peter Nordström  
Umea University: Umea Universitet

Anna Nordström  
Umea University: Umea Universitet

Protocol

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Abstract

Background. The urbanization process has increased the stress level among the population, since the city is an environment characterized by pollution, traffic, and noise. Spending time in natural and green spaces revealed to be restorative and effective in stress reduction. In some conditions, it is not possible to reach green spaces, such as country or gardens. In the last years, virtual reality (VR) has been adopted in laboratories to explore the potentialities for stress reduction. Therefore, the current systematic review protocol aims at establishing the main steps that will be undertaken to investigate the stress-reduction effects of virtual nature studies.

Methods. The study will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, while the inclusion criteria will be established through PICOS (Population, Intervention, Comparison, Outcome, Study Design). The studies will be included if based on non-clinical population; if they compare the exposure to virtual nature through 360° images, biophilic elements, VR pre-recorded videos, or immersive environment, excluding the augmented reality; if they measure the outcome in terms of objective measures (through physical parameters) or subjective measures (e.g., self-report questionnaires); and if they report quantitative outcomes, from scientific journals and indexed conference papers. The studies will be obtained through a research on Scopus, Web of Science, and PubMed. All the study characteristics will be summarised in a spreadsheet and a narrative synthesis including also tables will be presented.

Discussion. The current manuscript aims to provide the protocol that will be used in the systematic review concerning the stress reduction effect of virtual nature.

Systematic review registration. PROSPERO CRD42020213197.

Introduction

With the expansion of urban areas, the level of stress among the population has increased (1). The city is considered as a stressful environment characterized by traffic, pollution, noise, that may have an impact to the insurgence of psychiatric disorders (2, 3). Conversely, the exposure to green environments has been associated to positive mood, relaxation, and general well-being (4, 5). Within this perspective, scientific literature has explored the benefits of nature on the experienced level of stress, in terms of biological and psychological responses (6). Two main theories have been produced on the topic, namely the Stress Recovery Theory (7) and the Attention Restoration Theory (8). Both theories assume that spending time in a natural environment, or in an environment with natural elements, leads to positive affects like calmness, pleasure, interest, but according to the first theory, stress guides the individuals to find a place where is possible to restore, while the second one assumes that individuals are driven in this intent by mental fatigue (6). Moreover, according to the stress reduction theory, living in an urbanized environment tend to suffer more the stress (9). Therefore, since it is estimated that people living in an urbanized environment will grow to 68% (10), also the average stress level among the population will increase accordingly.
For several reasons, not all the natural environments are accessible for people living in the cities (11). For example, elderly living in assisted care facilities could have limited possibilities to visit natural gardens or forests, or people living in the cities cannot have the time to spend some time in the nature (12). Lately, the development of new technologies simulating real-life environments has determined a growing interest towards the psychological effects of their use (13).

Scientific literature has investigated if the exposure to nature through Virtual Reality (hereinafter, VR) could have similar effects to the real natural environment in terms of stress reduction, relaxation and restoration effects (14–16), that in this review are meant to indicate the same concept. Furthermore, the studies following this research question range from the introduction of some natural elements in a room, namely, the biophilic environment, to the immersive experience in a VR forest.

Previous systematic reviews investigated the restorative effects of nature (17) and the stress-reduction of VR in the workplace (18), but no reviews were found concerning the stress-reduction effects determined by the exposure to virtual nature. Considering that the topic has a relevance in the public health sector (19), specifically for what concerns mental health (20), the current systematic review will aim to fill this gap, examining the stress-reduction effects, both physiological and psychological, derived from the exposure to the VR nature.

Methods

The systematic review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (21, 22). Moreover, the protocol has been already registered on PROSPERO, with the registration number CRD42020213197.

Eligibility Criteria

The eligibility criteria followed the PICOS checklist (Population, Intervention, Comparison, Outcome, Study Design) described by PRISMA (21) (Table 1). Concerning the population, the included studies will involve the non-clinical population. Therefore, all the studies dealing with a population affected by physiological (e.g., Alzheimer, cancer, HIV) or psychological (PTSD, anxiety, stress-related disorders) will be excluded. The interventions considered eligible will relate the exposure to virtual nature through 360° images, biophilic elements, VR pre-recorded videos, or immersive environment, excluding the augmented reality. No restrictions will be considered about the possibility of inducing the stress. Moreover, this systematic review does not frame the intervention into a psychological perspective, thus cognitive behavioural techniques (CBT) and mindfulness program are excluded.

Regarding the comparison, the studies considered eligible will compare the use of virtual nature with non-virtual landscapes, urban landscapes, real nature landscape conditions, or other kind of stimuli (e.g., sound-related stimuli). The studies that compare also physical exercise or movement will be excluded.
The measured outcome will be the reduction of stress, the restoration and the relaxation effects, measured objectively (through physical measures) or subjectively (e.g., self-report questionnaires on stress levels). Physical measures will include the heart-rate variability (HRV), systolic and diastolic blood pressure variation, salivary alpha amylase activity, salivary cortisol, heart rate, galvanic skin responses. No exclusion criteria are forecasted. For the psychological responses, the preferred criteria will be the use of standardized questionnaire about stress.

The studies considered eligible are all the intervention studies with quantitative outcomes, from scientific journals and indexed conference papers. Reviews, meta-analyses, abstracts, book reviews, and editorials will be excluded.

Table 1

Eligibility Criteria according to Population, Intervention, Comparison, Outcome, and Study Design (PICOS) criteria;

| PICOS          | Inclusion Criteria                                                                 | Exclusion Criteria                                                                 |
|----------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Population     | Non-clinical population                                                            | Population affected by physiological (e.g., Alzheimer, cancer, HIV) or psychological (PTSD, anxiety, stress-related disorders) diseases. |
| Intervention   | Virtual nature through 360° images, biophilic elements, VR pre-recorded videos, or immersive environment | Augmented reality, Cognitive Behavioural Theory, Mindfulness program                  |
| Comparison     | Comparison between the use of virtual nature with non-virtual landscapes, urban landscapes, real nature landscape conditions, or other kind of stimuli (e.g., sound-related stimuli) | VR combined with physical exercise or movements                                       |
| Outcome        | Physiological stress reduction                                                      | No restrictions                                                                    |
|                | Psychological stress reduction (standardised questionnaires preferred)              |                                                                                     |
| Study design   | Quantitative studies                                                               | Reviews, meta-analyses, abstracts, book reviews, and editorials will be excluded.   |

Information Source

The information sources will include Web of Science, PubMed, and Scopus. Data screening will concern the selection of manuscript based on the title and topic of natural virtual reality and stress reduction.

Search Strategy

The following groups of keywords will be searched in combination with the Boolean indicator AND:
Keywords\textsubscript{1}: “virtual reality”, “virtual nature”, “virtual landscape”, “immersive environment”;

Keywords\textsubscript{2}: “natural environment”, “biophilic environment”, “forest”, “nature”;

Keywords\textsubscript{3}: “stress reduction”, “stress relief”, “restoration”, “restorative”, “relaxation”;

Each search keyword will be used in combination with another keyword term of the other groups on PubMed, Web of Science, or Scopus, as showed in the following string example: (((“virtual reality” OR “virtual nature” OR “virtual landscape” OR “immersive environment”) AND (“natural environment” OR “biophilic environment” OR “forest” OR “nature”) AND (“stress reduction” OR “stress relief” OR “restoration” OR “restorative” OR “relaxation”).

\textbf{Study record}

\textbf{Data management}

The manuscripts will be collected by two independent Authors (AG and AN), that will perform all the steps to ensure that the manuscript selection will be not affected by the researcher characteristics. First, the selection will be performed through EndNote (EndNote version X7.5; Thompson Reuters, New York, USA) and the function “find duplicated” will be selected. Afterwards, a manual selection of the eligible manuscripts will be performed by the two investigators, considering the main aim of the systematic review, following three steps: the title screening, the abstract screening, and the full-text screening. The discrepancies between the two investigators will be solved by the involvement of the other investigators (AB and PN). The investigators will be aware of all the information contained within the manuscripts, such as study title, authors, and affiliations. A PRISMA flow diagram will be used to represent the search strategy and the resulting outcomes.

\textbf{Selection process}

The studies will be considered if they are written in English, independently from the country of origin of the study. The selection process will concern the acquisition of each study and then its examination according to the inclusion and exclusion criteria.

\textbf{Data collection process}

Data collection will be performed according to the following procedure. Information about the lead author, year of publication, type of study, study design (between/within participants) sample size, conditions forecasted by the study, stress induction procedure, objective measures of stress, subjective measures of stress will be extracted and included into a Microsoft Excel (Microsoft Corp, Redmond, Washington) spreadsheet.

\textbf{Risk of Bias}
The risk of bias will be evaluated through the Cochrane risk of bias tool (23), which considers six potential sources of bias, namely: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias. Each source is identified by one or more items whose assessment is divided in two parts: a free-text judgment of the risk of bias and a judgment on a scale of high, low, or unclear risk of material bias. Two independent Authors (AG and AB) will complete the tool, and a rank correlation will be performed to evaluate the agreement between studies. Relevant discrepancies will be solved through the involvement of the other two Authors (PN and AN).

Data synthesis

All the collected information will be summarized through tables, with the aim of showing the general effect produced by virtual nature on stress reduction. Tables will include information about each study, the principal methodological features, and the main results delivered. The considered outcomes within the current systematic review will concern the physiological and psychological effectiveness of VR nature. A narrative description of the outcomes, both from physiological and psychological measures, will be provided. Moreover, a description of other features significantly affecting the results (such as sound of nature, brightness level of the landscape) will be discussed.

Discussion

The current systematic review will point out the main features of a VR intervention for stress reduction in the general population.

Since the costs associated to the Headsets Mount Displays (HMD) are slowly reducing, the application of VR technology has been progressively spreading across various contexts. The effectiveness of a VR nature environment could have implication at public health level, since the technological intervention could overcome the scarce accessibility to the green space (24). Moreover, it could be a useful tool for people with disability, reduced mobility, or living in healthcare structures (25, 26). Another context where VR has many potentialities is the workplace, where this tool revealed to be effective in reducing stress among workers (18), preventing the burnout syndrome in high-risk professional workforce, such as physicians (27).

Several aspects will be investigated through this review. Specifically, it will compare the effects of nature VR scenes with urban environments, with real nature, or without any kind of intervention. The role of some specific characteristics (sound, brightness of the scenes, immersive environment) will be further analyzed. Finally, it will investigate the physiological (breathing, blood pressure, heart rate, salivary cortisol, skin galvanic response) and the psychological (positive mood, anxiety reduction, self-reported stress reduction) effects of the virtual nature.

In conclusion, the risk that may occur in the systematic review concerns the variability of methods and findings of the included studies. In this case, the structure of the review will reflect also the complexity of the phenomenon and the critical issues will be pointed out.
Abbreviations

VR: Virtual Reality;
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses;
PICOS: Population, Intervention, Comparison, Outcome, Study Design;
HRV: Heart-Rate Variability;
CBT: Cognitive-Behavioral Theory;
HMD: Headsets Mount Displays;

Declarations

Ethics approval and consent to participate.
Not applicable;

Consent for publication.
Not applicable;

Availability of data and materials.
Not applicable;

Competing interests.
the Authors declare no conflict of interests;

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