

Immersive Virtual Reality– based Serious Games interventions for ASD

A “Pocket Guide” evaluation framework



What is it?

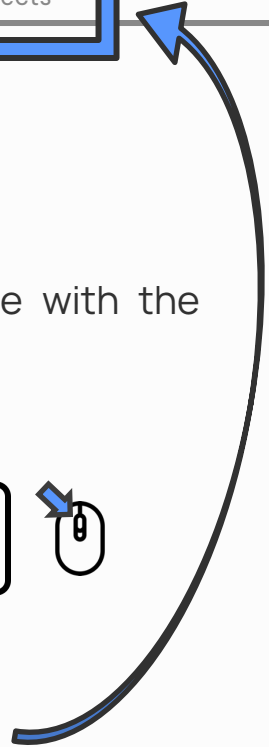
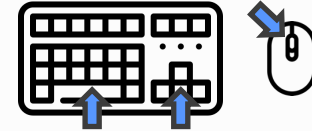
- A set of guidelines for conducting a rigorous evaluation process that meets the necessary methodological criteria.
- The framework encompasses all the specifications required to conduct an evaluation of interventions realized with immersive virtual reality based serious games for children and adults with autism.

How to use?

This Interactive PowerPoint presentation offers a **dynamic way** to engage with the **methodological criteria** involved in the **proposed evaluation framework**.

It allow for:

- **traditional linear navigation** (i.e., by clicking the left mouse button, pressing the space bar or arrow keys on the keyboard)
- **non-linear navigation** through clickable menu items, standing for the methodological criteria involved in the proposed evaluation framework.



How to use?

For each methodological criterion or sub-criterion you can find:

Name of the
methodological
criterion/sub-criterion

A description of the
methodological criterion/
sub-criterion

Multidisciplinary team

- The multidisciplinary team is particularly crucial when the technological system targets a clinical population such as individuals with ASD. It is recommended to have a multidisciplinary team that collaborates on the design, implementation, and evaluation of an IVR-based SO intervention for ASD.
- The team should include domain experts such as experienced ASD psychologists, educators, and information and communication technology experts.
- It would be desirable that end users (i.e., people with ASD) and other stakeholders (e.g., family and caregivers) are also involved in making decisions about what is developed and how. This approach follows an inclusive and participatory methodology that is ethically more appropriate for designers and end products. Indeed, end users and other stakeholders are involved from the beginning of the process rather than being product testers. Likewise, an inclusive and participatory methodology provides superior protection of ethical aspects for ASD individuals.



TO-DO list:

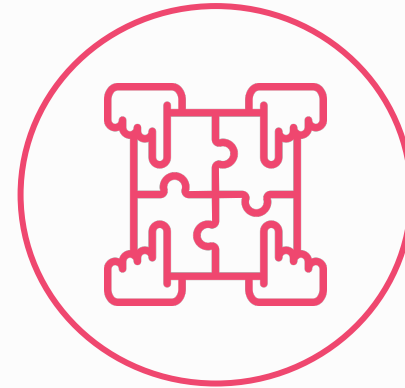
- ☐ Assemble a multidisciplinary team.
- ☐ Actively involve people with ASD and their parents and caregivers.
- ☐ Adopt an inclusive and participatory approach.

Representative Icon

A list of actions to be
performed to address the
related methodological
criterion/sub-criterion

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Introduction

Multidisciplinary
Team

**Sample
Characteristics**

Experimental
Design

Intervention

Level of Aversion
or Negative Effect
of IVR technology

Ethical
Aspects

Sample Size

Age of
Participants

Ratio
Male:Female

ASD as the
Control Group

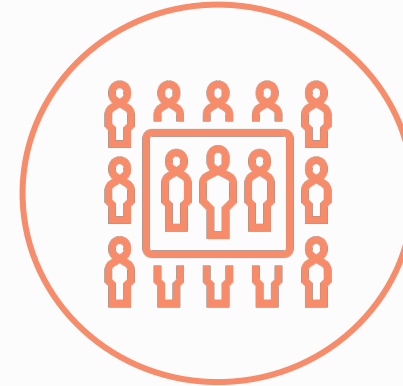
With or without
Intellectual
Disability

Level of Severity

Exclusion or
Inclusion

Sample Characteristics

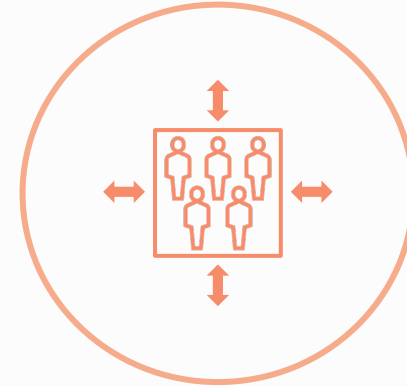
- Sample Characteristics are crucial to consider when evaluating an IVR-based SG for ASD.
- This methodological criterion refers to the demographic, clinical, and individual characteristics of the participants in the evaluation study.
- Understanding the sample characteristics helps to determine the generalizability of the findings. By examining the age range, gender distribution, and other characteristics of the sample, researchers can assess whether the results can be applied to a broader population of individuals with ASD.
- This methodological criterion includes a series of methodological sub-criteria to be considered when defining the sample of participants.



Click on the **items** in the **submenu** to explore the associated **sub-criteria** within this methodological criterion

Sample Size

- In order to ensure the discrete generalizability of the results, it is recommended a sample size of at least ≥ 30 since it allows the distribution to be nearly identical to the normal curve. The need for a normal curve derives from the fact that it is the most common curve in nature if it assumes that the influences on the results are truly random.
- However, when the sample consists of clinical subjects such as ASD individuals, it is much more complicated to ensure an adequate sample size. In order to overcome this issue, it is recommended to use a statistical test known as Power Analysis (Cohen, 2013) at the beginning of the study to determine the appropriate sample size according to the research question.



TO-DO list:

- ☐ Sample size ≥ 30 .
- ☐ In alternative, use Power Analysis to determine the appropriate sample size.

Introduction	Multidisciplinary Team	Sample Characteristics	Experimental Design	Intervention	Level of Aversion or Negative Effect of IVR technology	Ethical Aspects
Sample Size	Age of Participants	Ratio Male:Female	ASD as the Control Group	With or without Intellectual Disability	Level of Severity	Exclusion or Inclusion

Age of participants

- It is recommended to conduct studies with clustered age groups according to a universal age classification system, for instance, the one proposed by World Health Organization, since most abilities are age-dependent.



TO-DO list:

- ☐ Conduct studies with clustered age groups.
- ☐ Use a Universal Age Classification System.

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Sample Size

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**Ratio
Male:Female**

ASD as the
Control Group

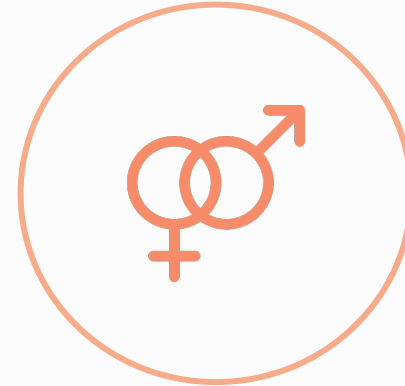
With or without
Intellectual
Disability

Level of Severity

Exclusion or
Inclusion

Ratio Male : Female

- It is recommended that the sample under a study respect the male-on-female ratio of around 3:1 since completely neglecting a component of the ASD population, even with a lower prevalence, could constitute a notable methodological issue.



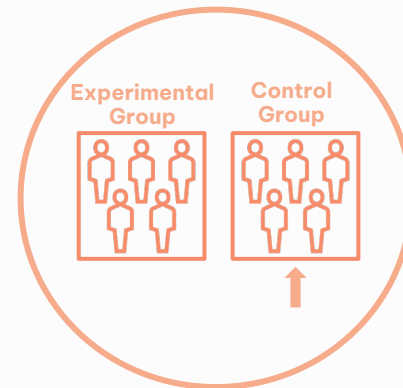
TO-DO list:

- ☐ Respect the Male-on-Female Ratio 3:1 in the sample composition.

Introduction	Multidisciplinary Team	Sample Characteristics	Experimental Design	Intervention	Level of Aversion or Negative Effect of IVR technology	Ethical Aspects
Sample Size	Age of Participants	Ratio Male:Female	ASD as the Control Group	With or without Intellectual Disability	Level of Severity	Exclusion or Inclusion

ASD as the Control Group

- It is recommended that the entire experimental and control sample under a study consist of individuals with ASD.
- It is necessary to check the methodological criterion of inter-group comparability by ensuring that the experimental intervention is the only discriminating variable between the two samples.



TO-DO list:

- ☐ Include only ASD individuals in the control group.
- ☐ Ensure that the experimental intervention is the only discriminating variable between the experimental group and the control group.

Introduction	Multidisciplinary Team	Sample Characteristics	Experimental Design	Intervention	Level of Aversion or Negative Effect of IVR technology	Ethical Aspects
Sample Size	Age of Participants	Ratio Male:Female	ASD as the Control Group	With or without Intellectual Disability	Level of Severity	Exclusion or Inclusion

With or without Intellectual Disability

- It is recommended that studies provide information on the presence or absence of intellectual disability tested by specific and standardized test since this information is essential for all aspects of research, from technology design to the type of skill to be treated.



TO-DO list:

- ☐ Provide information on the presence or absence of intellectual disability in participants.
- ☐ Ensure testing is done by specific, standardized tests.

Introduction	Multidisciplinary Team	Sample Characteristics	Experimental Design	Intervention	Level of Aversion or Negative Effect of IVR technology	Ethical Aspects
Sample Size	Age of Participants	Ratio Male:Female	ASD as the Control Group	With or without Intellectual Disability	Level of Severity	Exclusion or Inclusion

Level of Severity of ASD

- It is recommended that studies published post-2013 define the level of ASD severity according to DSM-5 instead of using outdated diagnostic classifications such as Asperger's Syndrome. It would allow for appropriate and current diagnostic uniformity.



TO-DO list:

- ☐ Specify the level of ASD severity of participants according to DSM-5.

Introduction	Multidisciplinary Team	Sample Characteristics	Experimental Design	Intervention	Level of Aversion or Negative Effect of IVR technology	Ethical Aspects
Sample Size	Age of Participants	Ratio Male:Female	ASD as the Control Group	With or without Intellectual Disability	Level of Severity	Exclusion or Inclusion

Exclusion or Inclusion

- It is recommended to use both inclusion and exclusion sub-criteria. The first, since ensuring that key characteristics of a target population are selected; the second, since ensuring that potential participants that met the inclusion sub-criteria but have additional characteristics that could interfere with the success of the study are excluded.
- Having inclusion and exclusion sub-criteria for clinical study participants is a standard, required practice for designing high-quality research protocols to ensure the generalizability of the results.

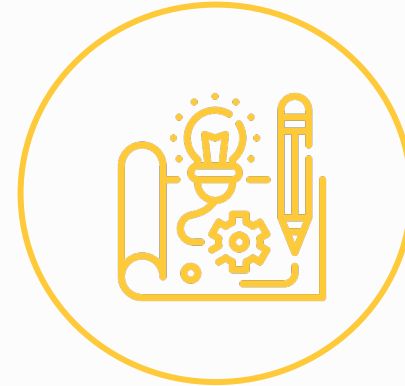


What to do:

- ❑ Define inclusion and exclusion criteria to select or exclude participants of an evaluation study.

Experimental Design

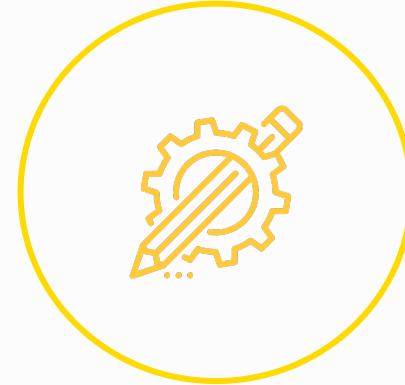
- The Experimental Design is crucial to consider when evaluating an IVR-based SG for ASD.
- This methodological criterion refers to the systematic process of planning, conducting, and analyzing an experimental study.
- This methodological criterion includes a series of methodological sub-criteria to be considered when designing an experimental study.



Click on the **items** in the **submenu** to explore the associated **sub-criteria** within this methodological criterion

Statistical Design

- At the beginning of a research, it is recommended that studies plan the statistical analysis according to the specific research question. This planning allows for a methodologically controlled definition of the variables being studied.
- Likewise, all studies should always include a follow-up since it is necessary to verify the efficacy and effectiveness of an intervention over time



TO-DO list:

- ☐ Plan statistical analysis.
- ☐ Define variables to be studied.
- ☐ Include Follow-Up.

Testing Method for Psychological Variables

- In order to have a methodologically controlled study, it is recommended to define and adopt valid and standardized tests to evaluate the efficacy and effectiveness of the study itself.



TO-DO list:

- ☐ Identify valid and standardized tests to evaluate psychological variables

Testing Method for Technological Measures

- In order to have a methodologically controlled study, it is recommended to define and adopt valid and standardized tests to evaluate the efficacy and effectiveness of the study itself.

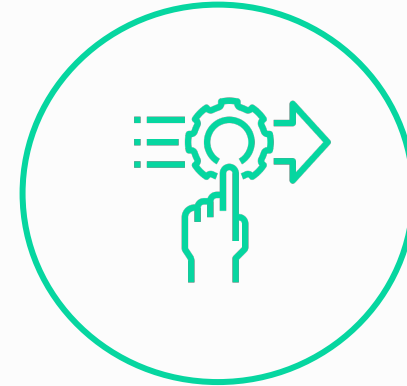


TO-DO list:

- ☐ Identify valid and standardized tests to assess technological measures.

Intervention

- The intervention itself is crucial to consider when evaluating an IVR-based SG for ASD.
- This methodological criterion refers to the treatment or action that is being tested or evaluated in the study.
- This methodological criterion includes a series of methodological sub-criteria to be considered.



Click on the **items** in the **submenu** to explore the associated **sub-criteria** within this methodological criterion

Level of immersion

- Immersive virtual reality technology can provide a low, moderate, or high level of immersion.
- It is recommended that studies specify the level of immersion, and they specify how much the level of immersion goes into impacting the outcome of the intervention.



TO-DO list:

- ☐ Specify the level of immersion provided by the adopted IVR technology.
- ☐ Determine the impact of the specified level of immersion on the outcomes of the intervention.

Kind of ability

- It is recommended to define the type of ability focus of the intervention based on a known classifier, for example, the one proposed by the American Association on Intellectual and Developmental Disabilities, ensuring standard definitions enjoyable by different professional profiles.



TO-DO list:

- ❑ Define the type of ability focus of the intervention according to a known classifier (e.g., the classification proposed by the American Association on Intellectual and Developmental disabilities)

Engagement

- It is recommended to evaluate engagement since if the study participants are not involved enough, they will not continue to use the system.
- Specifically, it is recommended to use objective measures to evaluate engagement, such as standardized tests and questionnaires that ensure replicable results.



TO-DO list:

- ☐ Evaluate the engagement of study participants through the use of standardized tests and questionnaires.

Acceptability

- It is recommended, at the beginning of the intervention, to evaluate acceptability for successful of it.
- For example, if an individual with severe autism spectrum disorder does not tolerate the use of Head-Mounted Displat (HMD), an intervention implemented through an HMD may not be carried out.
- Specifically, evaluating the acceptability using standardized tests and questionnaires that ensure replicable results is recommended.



TO-DO list:

- ☐ Evaluate the acceptability of IVR technologies at the beginning of the intervention through the use of standardized tests and questionnaires.

Usability

- It is recommended to evaluate usability since it is essential for proper human-computer interaction during the intervention.
- Specifically, it is recommended to use objective measures to evaluate usability, such as standardized tests and questionnaires that ensure replicable results



TO-DO list:

- ☐ Evaluate the usability of the proposed IVR-based SG intervention through the use of standardized tests and questionnaires.

Level of Aversion or Negative Effect of IVR technology

- It is recommended to consider this criterion since it is critical for the success of the intervention, especially for the clinical populations. Indeed, the intervention may be marred by several negative effects that are related to the use of IVR technologies. These include **cybersickness** which refers to a set of symptoms that can affect people when using IVR technologies. These symptoms are like motion sickness and can include dizziness, headaches, eye fatigue, vertigo and disorientation.
- Factors that can cause and exacerbate cybersickness include prolonged exposure to an immersive virtual reality-based experience, rapid movement in the field of view, lack of control over the immersive virtual environment, poor frame rate, and graphics.
- Therefore, negative effects and recommendations for the use of such technology must necessarily be taken into account.



TO-DO list:

- ☐ Take into account the negative effects related to the use of IVR technologies (e.g., cybersickness).
- ☐ Take into account the recommendations for the use of IVR technologies.

Ethical Aspects

- It is recommended to have ethics committee approval before starting a study. Ethics Committee must be declared within a study.
- Before starting the study, the study protocol must undergo evaluation and approval from an accredited research ethics committee. This committee must maintain impartiality and transparency, free from conflicts of interest with researchers or sponsoring institutions. Protocol breaches or adverse events during the study should be reported promptly to the committee following established regulations. Clinical studies must evaluate potential risks and benefits for participants. Researchers should minimise risks, monitor them continuously, and record risk factors.
- Participants should be fully informed about the study, voluntarily provide informed consent, and receive comprehensive information about the research, including purpose, method, expected benefits and risks, and conflicts of interest. If a participant can't provide consent, it must be obtained through a legally authorized representative (informed consent).



TO-DO list:

- ❑ Obtain ethics committee approval of the study protocol before starting.
- ❑ Inform participants fully about the study, including purpose, method, expected benefits and risks, and conflicts of interest.
- ❑ If a participant can't provide consent, obtain it through a legally authorized representative.

References:

- Peretti, S., Pino, M.C., Caruso, F., & Di Mascio, T. (2024) Evaluating the Potential of Immersive Virtual Reality-based Serious Games Interventions for Autism: A Comprehensive Evaluation Framework. *Educ. Sci.*
- Peretti, S., Caruso, F., Pino, M.C., & Di Mascio, T. (2023, September). A Systematic Review to Know How Interventions Realized with Immersive Virtual Reality-Based Serious Games for Individuals with Autism are Evaluated. In *Proceedings of the 15th Biannual Conference of the Italian SIGCHI Chapter* (pp. 1-14).

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