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Effectiveness and Usability of Technology-based Interventions with Children and Adolescents with ASD: A Systematic Review

MAZON, Cécile [1,2] ; FAGE, Charles [3] ; SAUZEON, Hélène [1,2]

[1.] Équipe-projet Phoenix, Inria Bordeaux Sud-Ouest

[2.] Laboratoire EA4136 HACS, Université de Bordeaux

[3.] Unité de Logopédie Clinique, Université de Liège

Abstract

Autism Spectrum Disorders (ASD) are neurodevelopmental disorders, characterized by impairments in social communication and by restricted interests and repetitive behaviors. The impacts of ASD on daily life are multiple and lead to social participation restrictions. To address this issue, a growing number of studies have explored Technology-Based Interventions (TBI) for supporting children with ASD in their daily life.

Two cores of studies can be distinguished according to research aims: 1) those related to computer-human interactions and focusing on usability, i.e., Technology Usability (TU), and 2) those related to health outcomes, i.e., Therapeutic Effectiveness (TE). The purposes of this review are: 1) to assess the study design of studies according to evidence-based standards, 2) to examine the quality of studies' measurements, and 3) to compare the methodology of two cores of studies (TE vs. TU).

From the 685 search results, 31 studies were selected, including 22 on TE, 6 on TU and 3 on both dimensions (TU-TE).

Among the most investigated TBI, studies on computers showed stronger evidence for effectiveness than those on robots, and socio-emotional skills were the most addressed with good evidence of benefits. Overall, few studies reached methodological standards. However, we note that TE studies have provided stronger evidence than TU studies, by more rigorously following methodological standards. The analysis showed that the evidence for TU or TE is related to studies' methodologies: 1) the more robust the study design, the less statistically significant the results, 2) the more reliable the measurement, the less large the effect size.

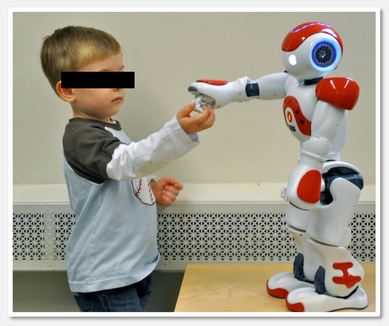
Further rigorous studies are needed for considering TBI as effective practices. Studies examining both TU and TE can be seen as an emerging approach, combining expertise in human-computer interaction and clinical research. As the clinical benefits of TBI necessitate usability, it is important to consider both dimensions in TBI studies.

Keywords: *technology, autism, systematic review, methodology*

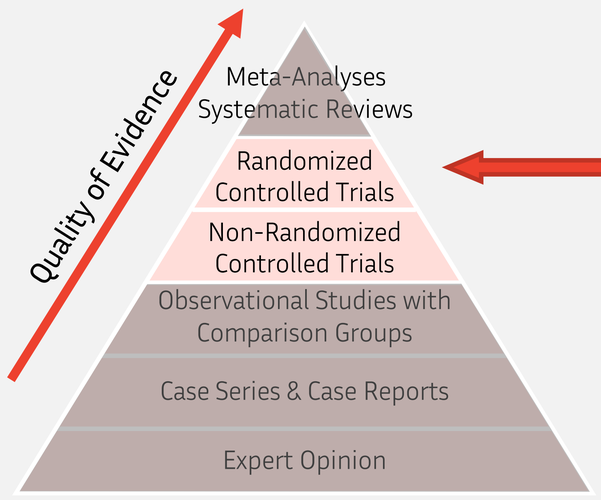


Autism Spectrum Disorders (ASD) are neurodevelopmental disorders characterized by impairments in social communication and by restricted interests and repetitive behaviors. The development and the evaluation of **Technology-Based Interventions (TBI)** for supporting individuals with ASD in their daily lives are an expanding research area.

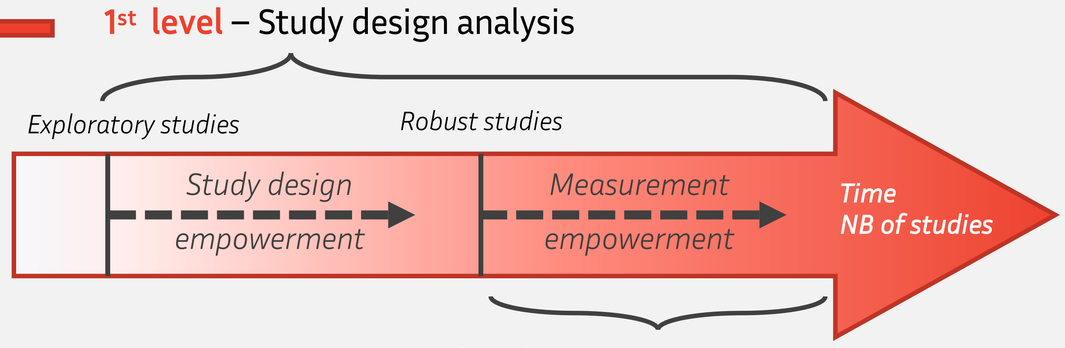
The recognition as an evidence-based practice requires the best possible research evidence in favor of TBI benefits. **Although argued promising practices, the evidence in favor of TBI effects remains too weak to consider them as evidence-based practices** (*e.g.*, Grynszpan, et al., 2014).



Providing Efficacy Evidence



1st level – Study design analysis



2nd level – Measurement analysis

Reliability

refers to a **psychometric property** of measurements. Standardized ones are the gold standards for guaranteeing **they actually measure the designated process or behavior.**

Durability

refers to the **maintenance of the effects** after the intervention. The question is whether **the effects still persist in time**, in the short and long term (**near and far effects**).

Consistency

refers to the **homogeneity of the effects**. An intervention should provide evidence of positive effects on the targeted outcome (**internal validity**), without side effects (**external validity**).

Generalization

refers to the **transfer of intervention effects to the everyday life** of individuals. This aspect is related to the **ecological validity**, *i.e.*, the adequacy between the measure and real-life activities.

Are TBI effective or usable ?

Studies addressing TBI effects with children and adolescents with ASD can be distinguished with respect to their research objectives:

Therapeutic Effectiveness (TE)

The primary aim of the study is to examine the effects of interventions in terms of **clinical** benefits.

Technology Usability (TU)

The primary aim of the study is to examine **ergonomic** aspects, in terms of usability and/or user experience.

The purposes of this review were to: **1) assess the study design** of studies according to evidence-based standards;

2) examine the quality of **studies' measurements**; and **3) compare** the methodology of two cores of studies, *i.e.*, **TE vs. TU**.

Method

A systematic review was conducted with nine databases:

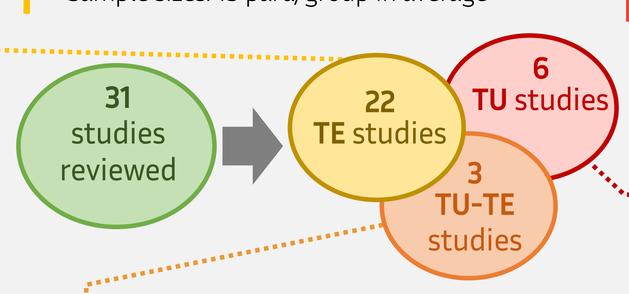
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Our selection was limited to peer-reviewed articles, in English, **from January 2000 to September 2016**. **SIGN criteria** were used for selecting the studies with the more robust design. We then applied the **Jadad criteria** on the remaining references for examining the quality of studies (randomization, double-blind design, drop-outs reports).

Data concerning participants, intervention settings and target, study design, outcome measurements, and results were extracted for the analysis. **Effect sizes were computed** from either means and SD, eta-squared, or test statistics (Student t-test, ANOVA).

1 Study design analysis

- 14 randomized and 8 non-randomized controlled trials including 18 pre-post designs
- Longitudinal evaluation and real-life settings
- Sample sizes: 15 part./group in average

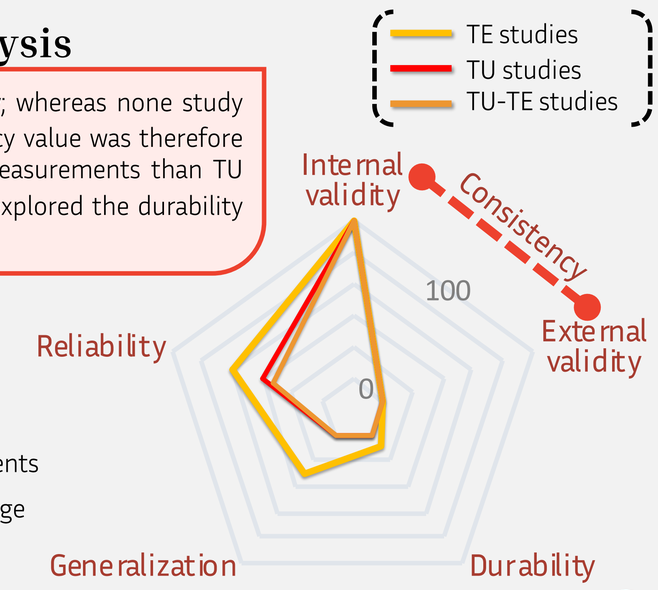


- 6 non-randomized controlled trials including 1 pre-post design
- Single session, controlled environments
- Sample sizes: 10 part./group in average

- 3 non-randomized controlled trials including 3 pre-post designs
- Longitudinal evaluation and real-life settings
- Sample sizes: 5 part./group in average

2 Measurement analysis

All studies addressed the internal validity; whereas none study addressed the external validity: consistency value was therefore limited. TE studies used more reliable measurements than TU and TU-TE studies, and some TE studies explored the durability and the generalization of TBI effects.



3 Studies' results

The studies' results may be related to studies' methodologies:

1. The more robust the study design, the less statistically significant the results.
2. The more reliable the measurement, the less large the effect size.

Conclusions

TE demonstrated more robustness in their methodology (*i.e.*, study designs and outcome measurements) than TU and TU-TE studies. This latter, however, attempt to provide a trade-off between TE and TU purposes for fully evaluating TBI effects. TU-TE studies appear therefore an emerging way of conciliating clinical and human-computer interaction expertise.

Further studies should strengthen their design and select more reliable measurements for actually demonstrating strong evidence about TBI effects with children and adolescents with ASD.