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# Effectiveness and usability of technology-based interventions for children and adolescents with ASD: A Systematic review of reliability, consistency, generalization and durability related to the effects of intervention

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## Abstract

### Background

In recent decades, a growing number of studies investigated the Technology-Based Intervention (TBI) (computer, phone, tablet, virtual reality, robot) for supporting children and teenagers with ASD in their daily life, notably in school settings. Previous systematic reviews indicated that these studies are methodologically too weak for any conclusive claim: TBIs are at best promising practices for ASD interventions (e.g., Grynspan, et al., 2014; Odom, et al., 2015).

### Objectives

Our purpose was threefold: 1) to update the previous systematic reviews of TBI studies for ASD with a focus on clinical-quality studies; 2) to examine reliability, consistency, durability and generalization of study measurements; and 3) to compare the methodology of two cores of studies according to two dimensions: *Therapeutic Effectiveness (TE)* and *Technology Usability (TU)*.

### Methods

Following the PICO method, a systematic literature search was conducted using 9 online databases from 2000 to 2016 with keywords related to autism, TE and TU. Resulting studies were selected using acknowledged quality criteria (SIGN, JADAD). Studies were then analyzed according to the following methodological dimensions: reliability (standardized- vs. non-standardized scales, objective vs. subjective measures), consistency (internal vs. external measurement of TBI's target), durability (near/far effect) and generalization (transfer or ecological value). From this stage, TE and TU studies were compared, and those addressing both dimensions were examined separately.

### Results

From the 917 search results, 31 studies were selected, including 22 on TE, 6 on TU and 3 addressing both dimensions (TE-TU).

Overall, TE studies were found more rigorous than TU studies with respect to study design, sample size and ASD-related inclusion/exclusion criteria. The majority of TE studies were RCT (14), with sufficiently large groups, deeply described. In contrast, TU studies involved small groups in controlled trials, and did not always provide a clinical description of their samples.

Regarding reliability of TBI effect, TE studies employed more standardized measurements than TU studies. Objective measurements were used in most studies. Regarding consistency of TBI effect, internal validity was respected in both TE and TU studies, whereas external validity was not. When considering studies' results, interestingly, the more the study design was robust, the more the consistency of results dropped: RCT with reliable measurement obtained less clear-cut evidence than controlled trials with less reliable measurement. Generalization measures were included in only 8 TE studies, and absent in TU studies. Results showed mixed evidence for the generalization of TBI effects. Durability of TBI effect was mostly occulted. Only two TE studies examined post-intervention, near/far effects and reported that TBI effects were maintained over time.

Finally, the three TE-TU studies were less rigorous than most TE studies. Both standardized or objective measures were used, showing the willingness to observe methodological standards. Furthermore, they addressed inter-

nal validity, but not external validity, durability and generalization. Results were fully positive, but limited by studies' weaknesses in terms of external validity, generalization and durability.

### **Conclusions**

Regardless of the dimension (TE, TU), very few TBI studies for ASD reached the standards of evidence-based practices (reliability, consistency, durability, generalization). Further rigorous studies are, therefore, needed for considering TBI as effective practices with children and adolescents with ASD. Nevertheless, TE studies provided more evidence of their reliability by using more standardized measures, particularly for TBI including computer software, which address emotional and social skills. Also, some TE studies took account of generalization and durability of TBI effects, while it was never the case for TU studies. The examination of reliability, consistency, generalization and durability supports therefore the distinction between TE and TU studies as two separate areas of TBI investigation.

However, TE-TU studies represent an emerging research approach, which deserves to be explored. Moreover, TE-TU studies demonstrated real efforts for meeting methodological standards, but without actual reaching minimal clinical standards of TBI evaluation. Nevertheless, this type of studies remains promising, as TBI usability is a prerequisite to TBI clinical effects. In other words, the clinical benefits of TBI necessitate usability, supporting the importance of considering the two dimensions in TBI validation studies. This situation calls for interdisciplinary development efforts of TBI for ASD, combining expertise in human-computer interaction and clinical research.