# Behavior Intervention in Virtual Reality
## *a case study on teaching turn taking to autistic children*

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## Summary

Turn taking is a critical developmental milestone for autistic kids. In this study, a virtual-reality (VR) game is developed to teach turn taking to children with level-2 autism. To increase engagement, we introduce options to allow customized environmental setups and personalized reinforcers based on individual's special interest. (e.g., spinning fans, elevators).

The result demonstrates the effectiveness of virtual reality in delivering behavior therapy for autism. Our experience suggests that closer collaborations between clinical practitioners and VR software developers are needed to enhance engagement and fidelity of the intervention.

## Purpose

- Develop a ball-throwing game that incorporates personalized elements to teach turn taking to children with level-2 autism.
- Evaluate feasibility and effectiveness of VR as a tool for autism intervention.

## Virtual Reality for Behavior Intervention



Typical consumer-grade VR system

- high-resolution head-mount display
- microphones and audio output
- motion sensors, cameras
- motion/gesture tracking algorithm
- ability to project to external display

Example: Meta Quest 3s, released in 2024, available for <$300.

***Pros*** ***and*** ***Cons***

- **Fun!**
- safe environment setup
- easy to display animated reinforcers
- affordability

- some people experience dizziness
- risk of sensory overload
- weight of HMD (Meta Quest 3s weighs about 500 grams)

***Some past research on VR intervention for autism***

- safe road crossing [1]
- job interview training [2, 8]
- interaction with police [5]
- joint attention [6]
- emotion recognition [3, 4]

Main limitations:

- Many targeting adults/adolescents and level-1 autism.
- Lack of personalization (key for engagement in level-2/3 autism.

## Game Design

**Material**: Meta Quest VR headset, laptop/TV. **Software**: Unity 3D, OpenXR.

**Gameplay**: Player throws ball to a virtual character who would throw it back.




## Method

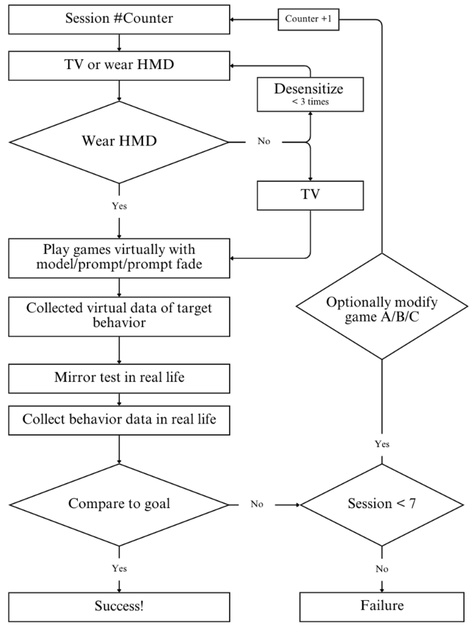
***Participants: 5 boys from northern California***

Screening criteria: autism diagnosis, aged 8+, unable to throw balls consistently with a peer.

| name | age | sex | verbal | starting HMD session | game appreciation |
|---|---|---|---|---|---|
| L-1 | 9 | M | limited | 2nd session | 4 |
| L-2 | 9 | M | limited | 1st session | 4 |
| L-3 | 8 | M | limited | 4th session | 5 |
| L-4 | 8 | M | limited | never, TV only | 3 |
| L-5 | 9 | M | limited | never | 1 |

***Evaluation Procedure***

- Watch screen cast of others playing for **desensitization**
- Iterative personalization by adjusting A/B/C to improve engagement
- Measure number of turns of ball throwing in real life
- Stops when the child can throw balls back and forth 50 times, or after 7 sessions

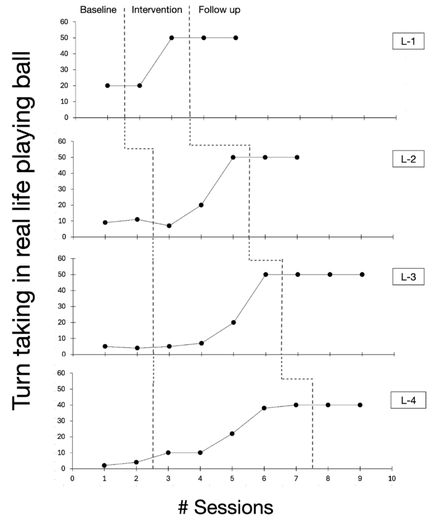



***Personalization on three-party contingency in ABA***

- **Antecedent**: prompt from therapist/caregivers, amount/type of furniture
- **Behavior**: multiple ways to control the ball (grab-and-throw gesture, clap, thumb-up)
- **Consequence**: customized animations, e.g., spinning ceiling fans



## Results




- L-1, L-2, and L-3 were able to wear HMD.
- L-4 never wore HMD, but pretended to play on TV.
- L-5 withdrew after 1 session (couldn't even tolerate TV).
- All five participants had previously undergone multiple years of conventional ABA therapy, with little progress on turn taking.
- Four of the participants show breakthrough after VR intervention.



L-3 starts to engage in ball game with classmates at school after intervention.

## Discussion

***Key factors to effectiveness of VR intervention***

- children's desire to engage in gameplay
- personalized reinforcers based on individual's special interest
- close collaboration between software developers and therapists

***Known imitations***

- small number of participants, lack of female representation
- not applicable to everyone due to tolerability issues
- concerns on safety on younger kids — need further study

***Possible ways to address cost of personalization***

- Use VR as a second-line therapy.
- Develop VR program that could load custom external 3D models (reinforcers) with configuration changes, so that a single version of the game.
- In future, use artificial intelligence to assist 3D modeling [7].

## References

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