The Sensory Toy Box: An Interactive Game-Based Technology As an Assessment Tool

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INTRODUCTION

- The diversity of sensory styles in individuals with Autism Spectrum Disorder (ASD) has been widely reported in the literature.
- Learning about each individual's sensory preferences can help identify sensory strengths and weaknesses that can assist in the selection of appropriate methods for teaching and treatment[1] and the design of optimal learning tools.
- Tangible interfaces allow different interactions with objects of various textures, shapes, sizes, and colors, that help the child engage actively in learning processes.
- Current assessment tools to determine sensory preferences are questionnaire based and typically completed by parents. Collecting data on sensory preferences directly from individuals with ASD seems to be challenging, especially from minimally verbal children.

OBJECTIVES

Overall objective: to develop the Sensory Toy Box, an interactive toy with an integrated data collection system, and to explore how it may enable us to learn more about sensory preferences of minimally verbal children with ASD.

DEVICE

The Sensory Toy Box is an interactive toy that recognizes different activations, such as a button press, texture touch and placement of RFID-tagged squares, and provides different types of feedback in the form of sounds and light in response. The device logs and stores data on the activations generated during play sessions.

Stimuli Selection

Environmental sounds, categorized in three main groups[2], Harmonic (HAR), Non-Harmonic/impulsive and periodic (NHI) and Non-Harmonic/Continuous and nonimpact (NHC), were selected as auditory feedback for different activation types. Visual feedback was grouped in a similar basis by changing the speed and light display pattern(Table 1). For the Texture activations, the same visual and audio feedback was used to assess texture preference.

Activation	Feedback Type	
Buttons	**Audio Feedback**	**Visual Feedback**
1	HAR	Color Wipe
2	NHI	Color Blinking Lights
3	NHI	Rainbow glow
Square tags		
4	HAR	Color Wipe
5	NHI	Color Blinking Lights
6	NHC	Rainbow glow
Textures		
7	NHI	White Blinking Lights
8	NHI	White Blinking Lights
9	NHI	White Blinking Lights

Table 1. Activation types numeration and feedback

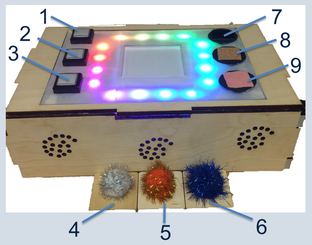

Fig 1. the Sensory Toy Box with labeled activation types

PARTICIPANTS

School-age children (N=4) with an ASD diagnosis played with the Sensory Toy Box and were assessed using the Sensory Profile 2 Questionnaire completed by their guardians.

ID	Gender	Age Years, months	Auditory	Visual	Touch	Seeking	Avoiding	Sensitivity	Registration
P1	Male	5,3	As typical	Less than others	As typical	29.47	Just like typical 25.00	30.53	22.73
P2	Male	7,6	More than others	Less than others	As typical	Just like typical 34.74	More 47.00	Just like typical 36.84	26.36
P3	Female	6,7	More than others	More than others	As typical	46.32	Just like typical 40.00	44.21	29.09
P4	Male	5,1	More than others	As typical	much more than others	67.37	Much more than typical 64.00	70.53	52.73

Table 2. Participants characteristics and sensory profile results

More than /less than others: Scores one standard deviation or more from the mean.
Much more/much less than others: Scores two standard deviations or more from the mean.

METHODS

Each play session had a 4 minutes duration:

- 2 minutes of free play with auditory feedback
- 2 minutes of free play with visual feedback

We examined engagement time, engagement type (spontaneous engagement against prompted engagement) and activations count and types as dependent variables in the context of sensory preferences and styles.

RESULTS

Engagement

Engagement time was greater during the visual feedback modality (Total engagement: Mean=79%; Spontaneous engagement: Mean=87.5%; Total activations: Mean=30) in comparison to the auditory feedback modality (Total engagement: Mean=69%; Spontaneous engagement: Mean=63.3%; Total activations: Mean=22).

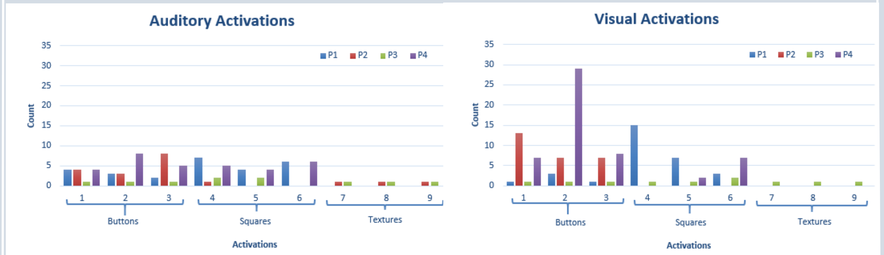

Fig 2. Activation Frequencies per participant during each modality.

P1 and **P4**, both close in age and with opposite Sensory Profile scores demonstrated the following individual preferences, refer to Table 1, and Figure 2.
P1: Visual: activation type 4 (N=15); Auditory: activation type 4 (N=7).
P4: Auditory: activation type 2 (N=8); Visual: activation type 2 (N=29).

"Other" Engagement for **P4** made up 32% of his total engagement and involved pressing hard on the center continuously every time he placed a square on the box. For **P1**, other engagement was not as frequent (6% of total engagement) and included stroking and touching the surface of the box to follow the light pattern.

Exploration Patterns

Figure 4 depicts the activations per participant during the auditory phase, the first phase each participant had exposure to.

P2's exploration graphs show preference for the buttons and depict a specific order.
P3 explored all three different areas of the box in the same manner.

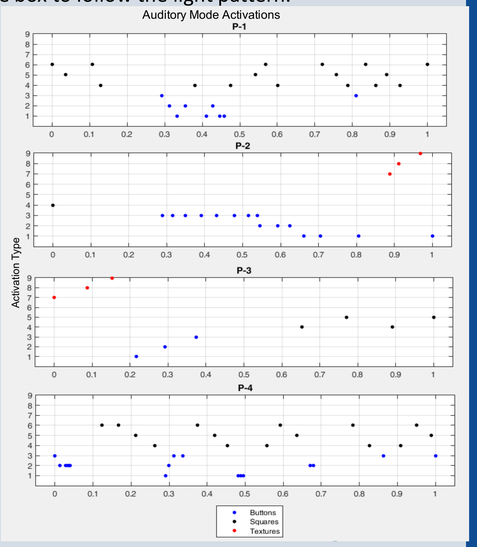

Fig 4. Activations through time during Auditory Mode

CONCLUSIONS & FUTURE WORK

In this work we have developed an initial prototype of an interactive technological tool to assist in the evaluation of sensory preferences in children with ASD.

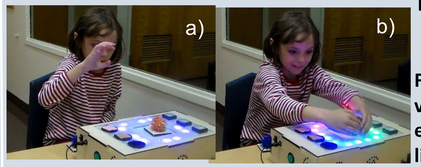

Fig. 5 a) participant activating the box in visual mode, activation type 5 b) participant engaged with visual response, covering lights, an example of "other" engagement

This preliminary study motivates further investigation in: 1) quantifiable measures of **Exploratory behaviors** through interaction with the device that could lead to 2) characterization of **sensory aspects** and help us in the 3) identification and **design of best reinforcers.** Ultimately, this will allow us to examine **learning and play** in the context of sensory preferences.

We hope to collect more data in comparable groups of Typically Developing children and children with Low Functioning ASD.

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