DESIGNING TANGIBLE TASKS FOR AUTISM PEOPLE: NADI

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Abstract

People with autism spectrum disorder (ASD) have different sensory stimuli that cause difficulties managing the tasks they need to do to sustain their daily lives such as how to communicate, how to respond, and even how to dress or cook. These sensitivities become their characteristics for their whole life even if they take proper education in the early period of their childhood. That's why it is essential to have an understanding of how people with ASD interpret the world and view people and objects around them. Tangible user interfaces may assist them to interpret the world by using physical forms of intangible knowledge since it helps them to capture the environment around them. For this reason, the interaction between the people with ASD and tangible user interfaces are examined based on the two foundational theories; Self-Determination Theory and Sensory Integration Theory, together with the TEACHH method. Then, user research was made firstly by conducting semi-structured qualitative interviews with autism people as well as educators who work with them and their family members. Then, workshops were made and key project findings were defined from an analysis of what had been observed and recorded. As a result, NADI is designed to provide an approach as a solution of the task management device for daily tasks to facilitate dealing with them, by using digitized physical interaction to improve people's autonomy together with helping them overcome anxiety/stress originated by routine breakdowns or unfamiliar situations.

Keywords

Product Design, Autism Spectrum Disorder, Interactivity, Tangible Interaction, Task Management

1. Introduction

Developing skills like cooking, getting dressed and cleaning are essential tasks to promote autonomy and self-determination and improve quality of life according to the researches [6, 7, 12, 17]. The role of design in assisting with these different situations, and, above all, encouraging are researched. The interaction with the services and products have effects on the people with ASD, so it is essential to realize and understand how they interact with the tools [24]. There are significant studies on Tangible User Interface (TUI) show that they assist in improving the quality of life of people with ASD to ease their lives [5, 18, 22, 23]. It is very vital to let each person achieve a greater degree of independence to unlock their potential. People with ASD require help to live in their own homes, whether as tenants or owners, alone or with others. To increase the quality of life for them, they need to gain the ability to make free decisions in order to be independent [10, 14].

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When we look at the data that shows the independence of the people with ASD, it shows that %17 of adults with ASD live independently, following high school and up to eight years after [2]. Together with, %44 of adults over 25 with an ASD live at home with their parents, rather than in any of the housing options. Of those adults living away from their families, only 4% are living fully independently, and 30% are living semi-independently in some form of supported housing [15].

Therefore, in this study, people, who are older than 18 years old, with ASD were chosen as focus groups by aiming to improve their autonomy for a more independent lifestyle. That's why, Self - Determination Theory and Sensory Integration Theory are researched carefully among the theories because they are the basis of the education of the people with ASD as approved theories [1, 24]. And, TEACCH (Treatment and Education of Autistic and Communication Handicapped Children) Method is used while designing the service/product since it fosters organized learning environments [8, 20].

2. Background Research

2.1. Foundational Theories and Method in Autism Spectrum Disorder

2.1.1. Self - Determination Theory

Self-determination is a combination of skills, knowledge, and beliefs that enable a person to engage in purpose-driven, self-regulated, autonomous behavior [3]. Being self-determined means taking the appropriate steps to attain one's objectives [24].

The term self-determination has a way to answer a lot of the needs of the person with ASD over the past decade, awareness of how the idea of self-determination applies to people who need special education has been significantly improved [6, 7, 12, 17]. Self - Determination Theory is involved in choice and decision making which is an important educational goal that can help people with ASD to interact with the environment, or try to go to university, work, or community involvement, for an independent life. All learners' educational programs will be guided towards encouraging and enhancing self-determination [17]. The findings indicate that even the youngest children (ages 5—6) were capable of setting goals and using the model to achieve them. So, theory aims to teach people how to understand, personalize, and implement in order to achieve self-selected objectives [19].

2.1.2. Sensory Integration Theory

Sensory Integration Theory helps increase the self-awareness of a person about the effect of sensory and motor influences on day-to-day behaviors and real-life circumstances. It offers ways to overcome sensory processing issues. It encourages optimal functioning and natural growth by promoting social well-being [15]. Sensory Integration Theory was developed by Dr. A. Jean Ayres. She developed and its application to people with cognitive disabilities [1]. A person's reactions to sensation affect everyday self-care routines; the ability to understand and pay attention to the task; the ability to manage the appropriate fine and gross motor skills; and the ability to prepare, order, and coordinate the time and resources to conduct these tasks within a fast-paced schedule or a busy household [16]. The theory aims to inform teachers, parents, children, and adults about sensory integration and develop strategies to adjust for dysfunctions [21].

Besides, the theory includes TEACCH (Treatment and Education of Autistic And Communication Handicapped Children Method) model activities to help sensory, cognitive, and behavioral needs [21].

2.1.3. Treatment and Education of Autistic And Communication Handicapped Children Method - TEACHH Method

TEACCH Method is a structured teaching educational technique that emphasizes visual support and aims at raising and optimizing independent functioning. Autism people respond more favorably to structured settings than unstructured ones. Program objectives help peoples' function to control their actions and inspire them through context and natural consequences, over unrelated contingencies and reinforcements individually [8, 20].

The primary learning features of people with ASD, include struggles in planning, distracting, organizing, and generalizing, allow therapy to be structured around the unique strengths (e.g., visual-spatial organization) and needs (e.g., structure and predictability) of them [8]. The individual work system is described as a visually structured space where autism people work under the direct supervision of an adult or perform work previously mastered. While defining the task engagement as an activity in the absence of adult prompting as an independent functioning, the deficiency in independent functioning may be linked to inspiring lots of features [8, 20].

2.2. Importance of Tangible User Interfaces On People with ASD

Externalization of expressive representation by tangibility provides a focus for tasks, allows for the documentation of work, and can give users the ability to think and talk about objects that are being used [25]. According to Scaife and Rogers (1996), tangible user interfaces facilitate the external representations of an internal cognitive process via tangibles, which assists autism children to learn to interpret other people's behaviors and attitudes and provide time and space to advance their inner cognition [13]. When autism people struggle to understand the world around them, then they must face everyday difficulties in managing their environment. Giving them an opportunity for increased modification may bring new directions through an improved sense of control [4, 11, 18].

If we look at the environmental perspective, TUI focuses on tangibility and full-body experiences, incorporating computing into the daily world and intuitively helping use [9]. TUI provides physical, concrete interactions to make engagement with the environment and people easy since people with ASD have difficulties in understanding and perceiving the environment due to their characteristics. Tangibles can be especially appropriate for people with ASD since they take advantage of people because they are active learners who are rooted in the body and strengthened by sensory sensitivity [5, 25].

3. User Research

User research was made in two steps. Firstly, semi-structured qualitative interviews were conducted with people with ASD as well as educators who work with them and their family members, in total 15 people, by asking questions about some basic tasks such as how they do shopping, how they cook, how they use the transportation, etc. Material gathered during the research phase was used to uncover patterns, identify common problems, and define a framework to explain how the design of built environments can impact people with autism.

Results are defined as;

- Individual with ASD (5 participants)

"I prefer written recipes while cooking rather than watching the videos since it is so difficult to follow." Participant 1, Anonymous

"I am following a schedule that my teacher made; it makes my tasks easier during the day." Participant 2, Anonymous

- Educator (5 participants)

"We are generally making weekly tasks according to the level of them since we are meeting once a week or twice a week. Then, we are arranging their schedule."Semra Öztürk, Special Education Teacher

"We need to add new tasks to their routines depending on their level of autism in order to prepare them for real-life since, during the day, usually, you can face lots of unexpected situations that you have to deal with. When you add a new task to their weekly schedule, even if they do not want it, at least, they are going to try it." Nurhan Gökçe, Special Education Teacher

- Parent (5 participants)

"From the morning, she wakes up till they sleep, she is always following a visual schedule that shows the tasks she needs to do during the day. It is a list on her wall." Participant's Parent, Anonymous

"They are geniuses when it comes to the digital application; they can do anything. However, they also need to be aware of their environment" Participant's Parent, Anonymous

Then, the workshops were carried out with autism people in order to understand their way of thinking and needs by observing to see how they use the tools and how they act. From an analysis of what had been observed and recorded, key project findings and insights were defined.

The system, that should be designed for them, needs;

- Collaboration with educators
- To assist in organization the tasks
- To show the time management
- Visual discrimination
- Tangible interface for a more structured environment

4. NADI

Based on the literature study as well as the user research through interviews and workshops, NADI is designed as an approach to provide a solution. It is designed by aiming as an assistance service and product in managing daily tasks by assisting people with an autism spectrum disorder, especially for the young adults, to overcome anxiety and stress originated by routine breakdowns and unfamiliar situations, improving their autonomy during the day. NADI is a system as an interactive research product that consists of 2 components. One of them is the token which is RFID. It is a main tangible interactive button that allows arranging different daily activities. Users organize his/her day by using this tangible task button in order to perceive the steps during the day. The other one is the interactive base which contains an embedded RFID reader and LED pixel ring. When a token is placed step by step, the mat makes the LED pixel ring around the token in order to provide sensory feedback.

4.1. Scenario of Use

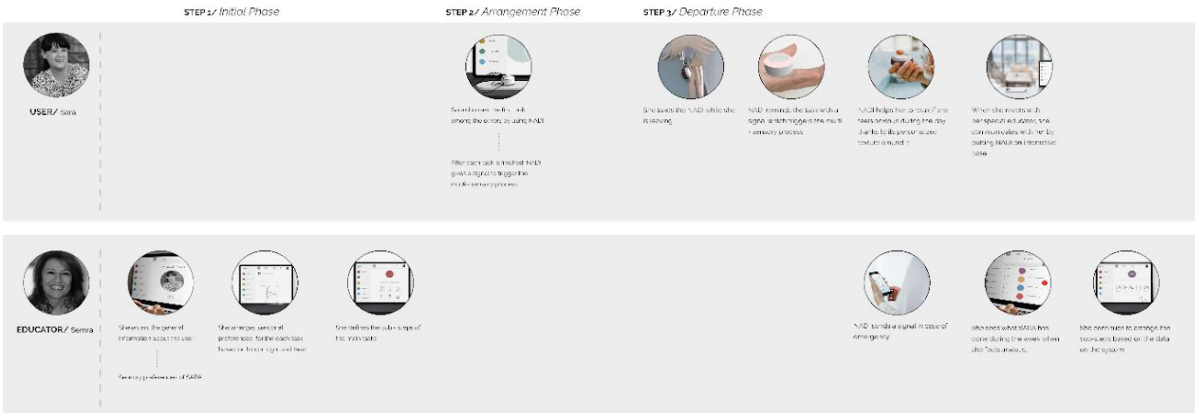

Figure 1: Scenario of use

NADI consists of 3 phases. Initial phase is about digital interaction while arrangement and departure phases are related with the physical interaction.

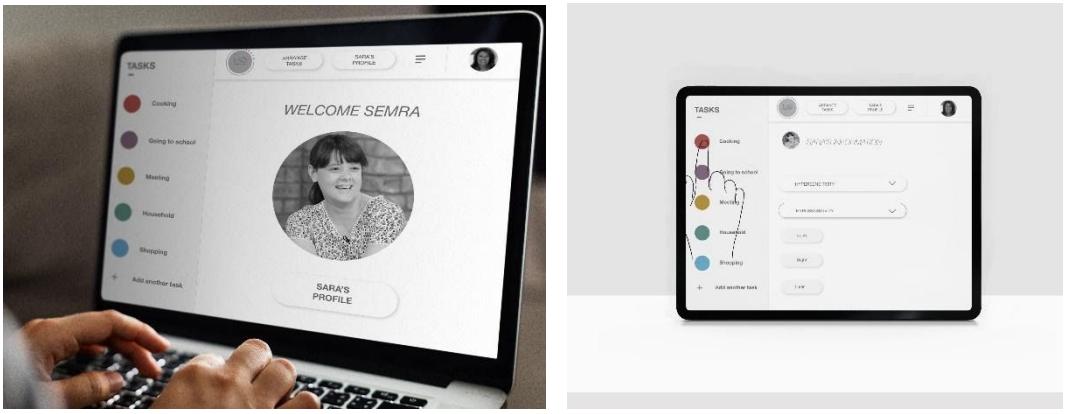

Figure 2: 1st step – Initial Phase

1st Step/ Initial Phase is about defining the main tasks and sub-steps of these main tasks throughout the digital application. These main tasks are represented in different colors for visual discrimination. Each task will have the sub-steps in order to define the proper plans for the user depending on the level of autism (Figure 2). The caregiver enters the general information about the user and arranges sensorial preferences for each task based on touch, sight, and hear that trigger multi-sensory processes.

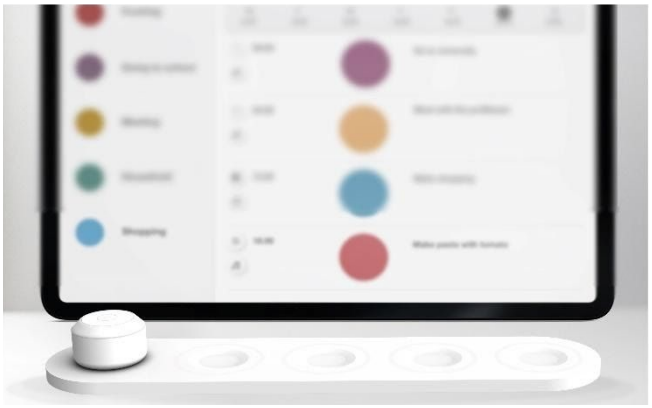
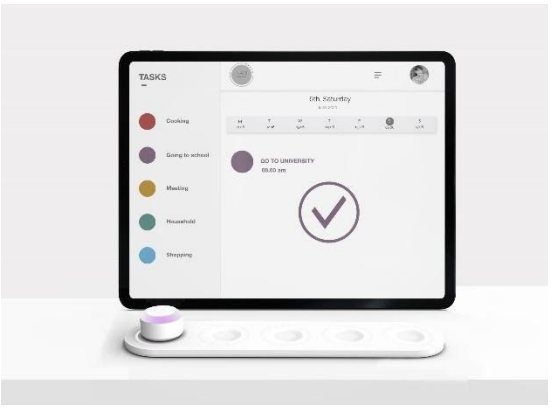

Figure 3: 2nd step – Arrangement Phase.

In this phase, the user starts to plan her/his day choosing the task and time by rotating the NADI on the interactive base. When s/he chooses, s/he just pushes the button on the top and then, music and light come up in order to stimulate the multi-sensory process that has been arranged before while arranging the main tasks and light, too. Then, s/he follows the whole process for the next tasks, step by step.

Figure 4: 3rd step – Departure Phase

In this phase, the user takes the NADI while leaving. It helps the user to cope with the unexpected situations during the day, such as forgetting the sub-steps of the actions and not knowing what will be the next one. When the new task comes, it gives signals, which are light and music in order to support the multi-sensory process.

Figure 5: Usage scenario

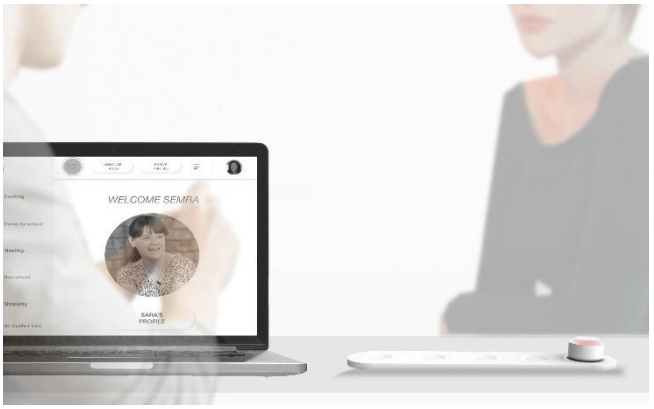

Figure 6: Usage scenario

Together with, in case of an emergency like breakdowns, the personalized texture around the product helps the user to feel safe by holding it (Figure 5). Besides, when the user meets with the special educator, s/he puts the NADI on the interactive base and the educator opens the account to reach data. Educator sees what s/he has done during the week when s/he feels anxious and NADI becomes a communication tool to help the user remember and talk about the tasks (Figure 6).

5. Evaluation

These results show us how vital it is to support the independence of people with ASD throughout their lives since they need to learn and adapt themselves to daily living situations, when the results are compared that come from the literature review and the user research. They need a work system to give them the feeling of being controlled, provide structured situations and let them understand the time and concept. They also need assistive technologies to assist them understand what is going on, what is going to happen and when it is going to happen. They should have personalized tools to prepare, order and coordinate the time and conduct with the task based on their level of autism and sensory preferences

Thus, NADI is designed to provide an approach as a solution of the task management device for daily tasks to facilitate dealing with them, by using digitized physical interaction to improve people's autonomy. It also aims to help them overcome anxiety/stress originated by routine breakdowns or unfamiliar situations. This project is a first attempt that needs to be tested and verified. The authors are open to collaborations in this sense and are finding opportunities to prototype and test both the product and the connected ecosystem.

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7. References

[1] A. Jean Ayres, and J. Robbins, Sensory integration and the child: Understanding hidden sensory challenges. Western Psychological Services, 2005.
[2] A. Brand, Living in the community: Housing design for adults with autism. London: Helen Hamlyn Centre, 2010.
[3] B. Mthimunye, A. Pedro and N.V. Roman, Autism Spectrum Disorder and Self- Determination Theory: The Importance of Family Involvement, Department of Social Work, University of the Western Cape, 2011.
[4] Copenhagen Institute of Interaction Design. Beyond the Desktop, 2008. URL: http://ciid.dk/education/ portfolio/py/courses/tangible-user-interface/overview/
[5] E. Hornecker and J. Buur, "Getting a grip on tangible interaction: a framework on physical space and social interaction." Proceedings of the SIGCHI conference on Human Factors in computing systems. 2006.
[6] E.J. Erwin and F. Brown, "From theory to practice: A contextual framework for understanding self-determination in early childhood environments." Infants & Young Children 16.1 (2003): 77-87.
[7] F. Brown and S. Cohen, "Self-determination and young children." Journal of the Association for Persons with Severe Handicaps 21.1 (1996): 22-30.
[8] G. B. Mesibov, V. Shea, and E. Schopler, The TEACCH approach to autism spectrum disorders. Springer Science & Business Media, 2005.
[9] G. Olley, Curriculum for students with autism. School Psychology Review, 28 (1999), 595–608.
[10] I. Johnston, Autism: Why do Many People Autistic People Die Before the Age of 40?, INDEPENDENT, 2016.

URL:https://www.independent.co.uk/life-style/health-and-families/health-news/autism-why-do-many-autistic-people-die-before-the-age-of-40-a6937911.html
[11] J. B. Rotter, "Internal versus external control of reinforcement: A case history of a variable." American psychologist 45.4 (1990): 489.
[12] K. A. Shogren,, and A. P. Turnbull, "Promoting self-determination in young children with disabilities: The critical role of families." Infants & Young Children 19.4 (2006): 338-352.
[13] M. Scaife and Y. Rogers. "External cognition: how do graphical representations work?." International journal of human-computer studies 45.2 (1996): 185-213.
[14] M. Vaillancourt, It's no surprise that people with autism have a low life expectancy, Our needs as adults are being ignored. INDEPENDENT, 2016. URL:https://www.independent.co.uk/voices/its-no-surprise-that-people-with-autism-have-a-low-life-expectancy-our-needs-as-adults-are-being-a6964751.html
[15] National Autistic Society. URL: https://www.autism.org.uk/about.aspx
[16] R. C. Schaaf and S. S. Roley. SI: Applying clinical reasoning to practice with diverse populations. Harcourt Assessment, Incorporated, 2006.
[17] S. B. Palmer and M. L. Wehmeyer, "Promoting self-determination in early elementary school: Teaching self-regulated problem-solving and goal-setting skills." Remedial and special education 24.2 (2003): 115-126.
[18] S. J. Wang, P. Moriarty and S. Wu. "Tangible interaction design: preparing future designers for the needs of industrial innovation." Procedia Technology 20.1 (2015): 162-169.
[19] S. K. Raley, K. A. Shogren and A. McDonald, "How to implement the self-determined learning model of instruction in inclusive general education classrooms." Teaching Exceptional Children 51.1 (2018): 62-71.
[20] S. Panerai, L. Ferrante and V. Caputo, "The TEACCH strategy in mentally retarded children with autism: a multidimensional assessment. Pilot study. Treatment and Education of Autistic and Communication Handicapped children." Journal of autism and developmental disorders 27.3 (1997): 345-347.
[21] W. Dunn. "Sensory Profile: User's Manual Psychological Corporation." San Antonio TX (1999).
[22] W. Farr, Y. Nicola and H. Raffle, "Collaborative benefits of a tangible interface for autistic children." Proc. CHI. 2009.
[23] W. Farr, Y. Nicola and S. Hinske, "An augmented toy and social interaction in children with autism." International Journal of Arts and Technology 5.2-4 (2012): 104-125.
[24] Y. Chou, et al., "Autism and self-determination: Factor analysis of two measures of self-determination." Focus on Autism and Other Developmental Disabilities 32.3 (2017): 163-175.
[25] Z. Kapetanovic et al., "Inclusive Design-Review of Student Projects." DS 30: Proceedings of DESIGN 2002, the 7th International Design Conference, Dubrovnik. 2002.