A Card-based Toolkit for Co-Designing Smart Interactive Experiences with Subjects with Neurodevelopmental Disorders

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Abstract

This paper reports on a co-design method that involves subjects with Neurodevelopmental Disorders (NDD) in the design of smart interactive experiences for themselves, i.e., aimed to enhance situations of their everyday life. Through a user-centered process that involved a sample of subjects with NDD and their therapists, we have identified a co-design toolkit that aims to favour reflection, by allowing subjects to feel engaged and empowered in solving concrete problems.

Keywords

Neurodevelomental Disorders, Co-Design, Tangibles, Card Tool-kits

1. Introduction

Neurodevelomental Disorders (NDD) are a multifaceted category of diseases deriving from problems appearing during the developmental age, which generate severe deficits in the cognitive, social, communicative, behavioral and emotional spheres [1]. The literature highlights how involving subjects with NDD in co-design methods combined with the exploitation of alternative communication channels (manual activities, small games, interactive tasks) can lead to effective processes with remarkable effects on the evolution of disability-oriented technology and services [2]. In this paper we report on preliminary considerations in the definition of a co-design method that involves subjects with NDD in the ideation of smart interactive experiences for themselves, i.e., able to support and enhance situations of their everyday life. We illustrate a user-centered process that involved a sample of subjects with NDD and their therapists, which will led us to extend an existing card-based co-design method [3, 4] with physical-digital material that can be adequate for the needs and preferences of subjects with NDD.

2. Rationale and Background

Participatory Design (PD) has been adopted in the last years for designing products and applications for people with NDD. The inclusion of subjects with NDD in the design process has impact not only on

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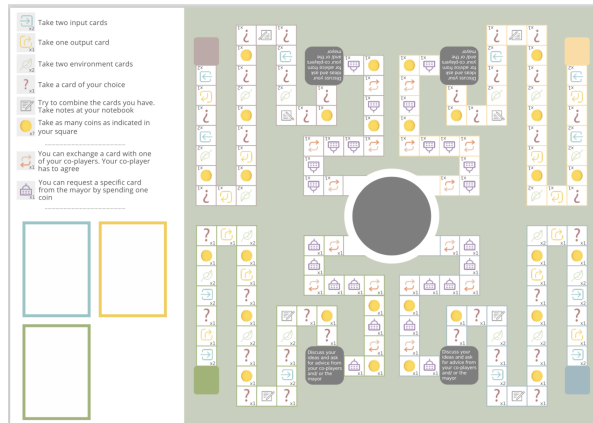
Figure 1: SNaP Cards

Figure 2: SNaP Game board

the quality of the final products but also on educational goals for the participating group itself. Card toolkits are often used in the generative phase of co-design methods to collaboratively build prototype artefacts [5]. A number of kits have been developed to help people ideating interactive applications. Among others, SNaP [3] is a collaborative game, with ideas taken from traditional board game design [6, 7]. It addresses children aged from 11 to 14 years old and aims to make them "protagonists" in the ideation and reflections concerning smart interactive experiences. The SNaP version used for the study reported in this paper focuses on experiences for enhancing outdoors activities, e.g., at the park.

The idea and layout of the cards are based on the Tiles Ideation Toolkit [8]. They include 18 *Environment cards*, representing objects that can be found in parks or outdoor non-urban environments; 20 *Input cards*, representing sensors and buttons that trigger an interaction; 5 *Output Cards*, representing actuators that react to the interaction (Figure 1). The Game Board (Figure 2) is designed for 2–4 players. During the game-play, players have the role of Designers. The game is facilitated by a moderator, with the role of Mayor. After different phases of card acquisition and discussion, all players "win" the game collaboratively; the game ends when each of them has designed at least an interactive object fulfilling his/her mission.

Figure 3: Familiarization workshop

Table 1
Workshop participants

Code	Gender	Age	Diagnosis
FEA57	M	24	Intellectual disability, mild autism, chromosomic disorder
FEA66	F	28	Mild intellectual disability, learning disability
FEA56	M	28	Genetic syndrome yet to be defined
FEA46	M	29	Psychotic obsessive-compulsive disorder, mild intellectual disability, celiac disease

3. Design process

Given the SNaP capability of facilitating reflection on needs and possible solutions, its focus on physical material (i.e., cards), and its regular scheme guiding the design activities, we wanted to assess in which measure the game could be adopted to empower subjects with NDD to reflect on their needs. We tried to engage them in the ideation of smart interactive experiences for themselves, i.e., able to support and enhance situations of their everyday life starting from the city park scenario. One of the main goal in education for people with disabilities is to give them as much autonomy as possible, even in travel and life outside their homes: we chose the urban park scenario in order to give them the chance to design an inclusive environment, where they feel comfortable. We thus conducted a workshop involving 4 subjects with NDD (see Table 1), followed by an interview with 2 therapists.

3.1. Workshop: familiarization with the game

The workshop (see Figure 3) was conducted to favour the familiarization of the subjects with NDD with the original game; the literature indeed considers familiarization an important element to improve subjects' contributions to the final design [9]. The entire session lasted 1 hour. The participants played SNaP following its standard rules and focusing on missions for enhancing activities in a city park. All the materials were translated in Italian. All the subjects appeared very engaged and enthusiast of playing with SNaP. They liked the cards and their graphics and understood their meaning. They were all able to ideate playful interactive games to enhance their stay at the park, for themselves and also for other visitors. For example, subject FEA57 thought of *"street signs that rotate every time someone passes by, to give directions to reach interesting, hidden spots of the park"*. The subject FEA46 ideated an interactive experience for deaf-blind visitors: *"flowers must be able to sense the proximity of a person and emit scents to offer an olfactory experience"*.

We interpreted these results as an indication of the subjects' engagement and understanding of the

Figure 4: Interview with the therapists

design context. The subjects also commented on the game dynamics. They suggested to include tricks during the game to further engage the players (for example, traps or going back a number of positions). They appreciated a lot having missions, because they provide guidance through the game and set a goal. One subject suggested adding a new (super-)mission for helping the other game participants to conceive their new ideas. This is an indication that they grasped the collaborative spirit of the game, till the point to think about a specific role to encourage ideation by every participant.

3.2. Interview with therapists

Adopting the game to involve subjects with NDD in the design of digital devices for their everyday activities soon emerged as a benefit. There are some work in the literature (see for example [10]) highlighting that, in spite of the growing focus on assistive technologies for children with NDD, there is a lack of approaches addressing other age ranges in which technologies might help subjects gain different types of skills. During an interview (see Figure 4), the two therapists who participated to the workshop indeed emphasized the opportunity for the subjects to reflect on their needs and on possible solutions. Very often, therapies focus on getting subjects to become independent in everyday tasks, especially those to be accomplished outdoor. Experiences at the park represent activities that can favour subjects' well-being and can encourage them to go outside. The therapists were therefore in favour of adopting the game in their therapies; they also suggested extensions (e.g., new cards) focusing on further activities, for example, reaching the grocery store, the pharmacy, the best friend's house. Reflecting on how digital devices can support all these activities becomes a means to reflect on the related adversities. The therapists remarked that the physicality of cards was a strength from a psychological point of view, because CD subjects need to see and touch physical material to improve their understanding of the context they have to focus on. The therapists suggested us to introduce additional interactive, physical-digital elements to further help players understand how to combine different cards and what the concrete effect of using sensors and actuators is in their interactive experiences.

4. Conclusion and Future Work

Thanks to the co-design approach this work focuses on, all participants had the chance to feel engaged and empowered in solving a concrete problem, i.e., the design of interactive park activities. On the other hand, they also played a crucial role in the design process of the method itself, as they gave very important feedback about the game. Therapists' feedback was important as well, as they suggested that a concrete and tangible board could enhance the participants' ability to think about different solutions. As shown in literature [11], people with NDD show some difficulties in abstraction, which could occur in a simple card game. These findings are coherent with other works [12] and suggest that tangibles could be very helpful for enhancing both learning and the creativity process. Our future work will concentrate on systematically assessing these benefits through the design and implementation of an interactive game board, to be used in combination with the original paper board, where the different sensors and actuators could be plugged in to see the effect of card combinations. We expect that spatial combination of tangibles can positively affect also participants' collaboration [13]. Then we will organize further workshops with the same subjects to have a feedback on prototypes of the interactive board.

References

[1] J. Olesen, A. Gustavsson, M. Svensson, H.-U. Wittchen, B. Jönsson, C. S. Group, E. B. Council, The economic cost of brain disorders in europe, European journal of neurology 19 (2012) 155–162.

[2] L. Sitbon, S. Farhin, Co-designing interactive applications with adults with intellectual disability: a case study, in: Proceedings of the 29th australian conference on computer-human interaction, 2017, pp. 487–491.

[3] R. Gennari, M. Matera, A. Melonio, E. Roumelioti, A Board-Game for Co-Designing Smart Nature Environments in Workshops with Children, in: End-User Development - 7th International Symposium, IS-EUD 2019, Hatfield, UK, July 10-12, 2019, Proceedings, is-EUD 2019, Springer, 2019, pp. 132–148. doi:10.1007/978-3-030-24781-2_9.

[4] R. Gennari, M. Matera, A. Melonio, E. Roumelioti, A board-game for co-designing smart nature environments in workshops with children, in: A. Malizia, S. Valtolina, A. I. Mørch, A. Serrano, A. Stratton (Eds.), End-User Development - 7th International Symposium, IS-EUD 2019, Hatfield, UK, July 10-12, 2019, Proceedings, volume 11553 of *Lecture Notes in Computer Science*, Springer, 2019, pp. 132–148. URL: https://doi.org/10.1007/978-3-030-24781-2_9. doi:10.1007/978-3-030-24781-2_9.

[5] E. B.-N. Sanders, P. J. Stappers, Probes, toolkits and prototypes: three approaches to making in codesigning, CoDesign 10 (2014) 5–14. URL: https://doi.org/10.1080/15710882.2014.888183. doi:10.1080/15710882.2014.888183. arXiv:https://doi.org/10.1080/15710882.2014.888183.

[6] K. Salen, E. Zimmerman, Rules of Play: Game Design Fundamentals, The MIT Press, 2003.

[7] J. Schell, The Art of Game Design: A Book of Lenses, Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2008.

[8] S. Mora, F. Gianni, M. Divitini, Tiles: A card-based ideation toolkit for the internet of things, in: Proceedings of the 2017 Conference on Designing Interactive Systems, DIS '17, ACM, New York, NY, USA, 2017, pp. 587–598. doi:10.1145/3064663.3064699.

[9] P. Marshall, Do tangible interfaces enhance learning?, in: Proceedings of the 1st international conference on Tangible and embedded interaction, ACM, 2007, pp. 163–170.

[10] S. Caria, F. Paternò, C. Santoro, V. Semucci, The design of web games for helping young high-functioning autistics in learning how to manage money, MONET 23 (2018) 1735–1748. URL: https://doi.org/10.1007/s11036-018-1069-0. doi:10.1007/s11036-018-1069-0.

[11] A. P. A. et al., Diagnostic and statistical manual of mental disorders (DSM-5), American Psychiatric Pub., 2013.

[12] T. P. Falcão, Action-effect mappings in tangible interaction for children with intellectual disabilities, International Journal of Learning Technology 12 (2017) 294–314.

[13] G. Desolda, C. Ardito, H. Jetter, R. Lanzilotti, Exploring spatially-aware cross-device interaction techniques for mobile collaborative sensemaking, Int. J. Hum. Comput. Stud. 122 (2019) 1–20. URL: https://doi.org/10.1016/j.ijhcs.2018.08.006. doi:10.1016/j.ijhcs.2018.08.006.