Understanding ASD Individuals' Difficulties with Managing Money

An Interactive Study

Serena Caria†
HIIS Lab
CNR-ISTI
Pisa, Italy
cariaserena91@gmail.com

Fabio Paternò
HIIS Lab
CNR-ISTI
Pisa, Italy
fabio.paterno@isti.cnr.it

Carmen Santoro
HIIS Lab
CNR-ISTI
Pisa, Italy
carmen.santoro@isti.cnr.it

ABSTRACT

Autism Spectrum Disorder (ASD) is a neurological disorder that impacts behavior, communication and social skills of affected individuals. The difficulty of youth with ASD to know how to properly approach other people leads to increasing isolation and stronger dependence on their parents, who often experience insufficient support especially after their children finish high school, when discontinuity of public assistive services is often experienced. In spite of being one of the most difficult developmental periods in their life, inadequate assistance is provided to learn practical, daily living skills, such as the key ability to manage money. In this paper, we report a study carried out with six teenagers with High-Functioning Autism, aiming to identify the difficulties they find in using money in real scenarios. In particular, the teenagers involved in the study exploited both a vending machine Web application for learning money-related skills and directly interacted with a real vending machine. Their interactions were analyzed to understand their behavior addressing situations involving purchases. The study employed a mixed method analysis approach incorporating subjective facilitator observations, objective task completion measures and eye tracking metrics to analyze their money management skills. The results reveal the difficulties that such individuals have to face in order to manage the concept of money in practice.

CCS CONCEPTS

• Human-centered computing ~ Empirical studies in accessibility

KEYWORDS

Accessibility, Autism Spectrum Disorder, Money, Serious games, Vending machine

†Author Footnote to be captured as Author Note

CHItaly'19, September 23-25, 2019, Padova, Italy

ACM ISBN 978-1-4503-7190-2/19/09…$15.00
https://doi.org/10.1145/3351995.3352038

ACM Reference format:

Serena Caria, Fabio Paternò and Carmen Santoro. 2019. Understanding ASD Individuals' Difficulties with Managing Money: An Interactive Study. In *Proceedings of ACM CHItaly conference (CHItaly'19). ACM, New York, NY, USA, 5 pages.* https://doi.org/ 10.1145/3351995.3352038

1 Introduction

In recent years, there have been some initiatives aimed at facilitating the societal inclusion of teenagers and early adult people with Autism Spectrum Disorder, who often have difficulties in conducting an independent life [1, 6]. This can also be attributed to the rather limited support that such category of users receives after exiting the secondary education system. On the road to independence, a lack of financial skills is a practical obstacle for many young adults with autism, particularly during their transition into adulthood. As highlighted in Peters et al. [7], despite the importance of financial autonomy and increased independence for youth with special healthcare needs, management and decision-making skills related to money are often seen as outside the purview of human service professionals working with such people, although these should be integral components of a more complete transition plan for such vulnerable persons.

Indeed, it has been shown that being able to manage one's own finances helps them to become independent, improves psychological well-being and helps the individual to better integrate within our society [5]. Furthermore, also people with ASD consider that managing money without the help of others equates to being an adult [6]. Thus, one relevant direction for facilitating their inclusion in society should be directed towards the acquisition of money management skills, starting from e.g. the recognition of different coins and banknotes, the ability to make payments and change coins and banknotes with others of equal value, the ability to make purchases with change [3]. Previous studies demonstrated that interactive technologies can be valuable tools in supporting computer-based learning of core problematic areas of autism, since individuals with ASD show a natural affinity with computers [5] due to the predictable and repeatable nature of technology. Thus, young ASD people are likely to profit from solutions that include

technological support and serious games [2] also for their financial capabilities. An example of such a solution is the Web application presented in [4], which was developed to teach money management-related concepts. While the results reported outline promising outcomes from its use in training end users on money-related skills, little is known regarding the ability of people with autism to manage money in real contexts of use, i.e. whether they would actually be able to apply the skills acquired through more conceptual training into practical situations of real life. In this study, we aim to reach a better understanding of the problems that people with autism can find in handling money in practical situations. For this purpose, we carried out a study that involved not only the analysis of the interaction of such individuals with a real vending machine, but also their interaction with a Web application aimed at providing them with specific training on money-related skills. Analyzing how the subjects used the Web application has been useful to help understand the difficulties that they find when managing money, for example in calculating the change. In the next section we describe the method used for the study, then we analyze the gathered results and discuss them, finally providing (Section 5) some concluding remarks.

2 The Study

The study involved six users with High-Functioning Autism (three males and three females) aged between 15 and 19 years old (average= 17,5, st. dev.=1,37). While five users were still attending secondary school, one user had already completed it. All the users involved in the tests had overall a good level of familiarity with PCs and also with smartphones, but not much familiarity with tablets. The teenagers involved in our study are part of a regional project whose goal is to assist individuals with ASD after high school so as to help them in the development of cognitive, motor, expressive, relational and social skills, according to a therapeutic program which also includes periodical structured checks. The ultimate goal is to have such individuals achieve progressively increasing independent living and social integration, with expected improvements of quality of life during adulthood.

We prepared an informed consent document asking the permission to carry out the study and log users' interactions, and declaring that the gathered data would have been aggregated to avoid identification. The document was approved and signed by the parents of the individuals involved in the test. The study was divided into two sessions, carried out one week apart. The first session was aimed at: i) defining a fact-finding baseline for the involved individuals (namely: assess their familiarity with technological devices, evaluate their money-related literacy, and analyze their familiarity with real vending machines); then, according to such identified, individual skills, provide them with personalized training by ii) asking them to use an interactive application specifically designed for helping them acquire the money-related skills they need. The second test session was carried out one week after the first session, and it was divided into two main steps: in the first step, the users had to play the same Web application games; in the second part, they interacted again with the real vending machine to buy two products, with the main goal to see if there was any improvement after the first session. In order to understand their familiarity with technological devices, we used a questionnaire in which we asked which technological devices they most frequently use, how frequently and for which purposes. In this questionnaire we also included additional questions to gather information about their previous purchasing experiences (how frequently, to buy what), also including previous uses of real vending machines.

In order to understand their money-related literacy (and the associated ability to handle calculations involving monetary values), the test moderator involved them in a game (involving real coins) in which they were asked to do some additions involving different denominations of real coins e.g. add: i) 0.20 euros + 0.20 euros + 0.10 euros; ii) 0.50 euros + 0.50 euros; iii) 1 euro + 1 euro. For instance, if users did not correctly answer questions related to additions, this would have implied to have them do the training with the Web game involving the sum of different monetary values. Furthermore, to gather information about their money-related skills in a real context of use, we asked them to use a real vending machine to buy two products, whose purchase also included the return of change. This was done to test not only their ability to calculate the change (and their familiarity with applying the subtraction concept when dealing with money), but also their ability to use a real vending machine.

Figure 1: The vending machine game

Then, depending on the information gathered about their familiarity with money-related skills, in the last part of the first session users received a personalized training, which consisted of interacting with only selected parts of the web application (Figure 1) aimed to allow individuals with ASD to acquire basic money-related competences. The underlying idea was that, if a user already had some specific skills in managing money (e.g. recognize the different coins, or adding the value of several coins), the part of the Web application aimed at teaching such skills could be skipped. This was done so that subjects carried out only tasks actually relevant (i.e. useful and motivating) according to their specific skills, also avoiding unnecessary long test duration.

The Web application includes four games: "Sum" (involving the addition of various monetary values, including both coins and banknotes), "Change" (involving the concept of money change and then the mathematical concept of subtraction), "Buy it!" (to train the user to understand what can be reasonably bought with a certain

amount of money), and "The vending machine" (in which users had to interact with a virtual vending machine).

The interaction with the Web application was also eye-tracked. We associated a task with each game of the Web application. No time limit was given to perform the tasks. For each task we calculated: task success, number of errors, time on task, and efficiency. The time was calculated in seconds, and we considered as errors incorrect answers to the questions posed by the game. We calculated efficiency by counting the actions performed by the user to complete each task. Task Success was calculated according to the following criteria:

- *Complete success*, when the user did not make mistakes and did not ask for help;
- *Minor problems*, when the user asked for some help or performed 1 or 2 errors, i.e. some of them asked for help during the most difficult subtractions in the game "Change";
- *Major problems*, when the request for help was more significant or the user made more than 2 errors, i.e. when someone was not able to calculate the additions during the game "Sum" and the educator was asked to help them;
- *Failure*: the user gave up or was unable to complete the task

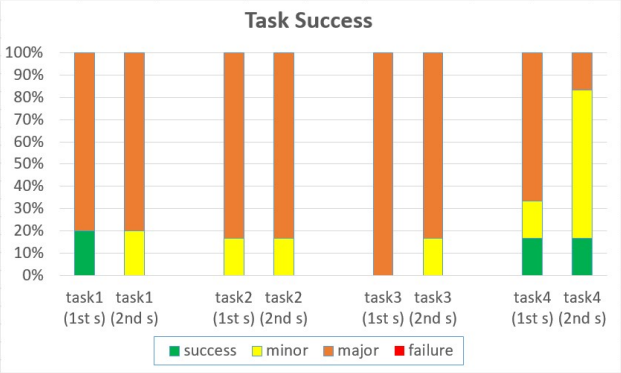

Figure 2: Task success in the first and in the second session

We also logged the interactions that users had with the web application. In addition, we used an eye tracker (with a Tobii Pro/X3-120) to understand the parts of the pages at which the users looked most, and to see if they paid attention to parts of the vending machine that are key for purchasing a product (e.g. the price of the product, or the number to type on the keypad for its selection). The analysis with the eye tracker was made both to reveal possible usability problems of the Web application, and also to derive indicators related to user eye movements performed within key regions of the application UI (e.g. the label indicating the cost of the products, the code to type for selecting a specific product of the machine) which can be connected with attention-getting objects or, on the contrary, elements harder to notice from the user viewpoint.

As for the eye tracker analysis, the part of the Web application involved was "The vending machine" game. For this analysis, we first created the areas of interest (AOI) associated with key elements of the game (e.g. the price of the product to buy, the change to obtain), and then we analyzed them using two metrics: Total Fixation Duration and Fixations Count. The Total Fixation Duration metric is the sum of the duration of all fixations on a precise AOI, while the Fixations Count metric indicates the number of times that the user looks at a specific AOI. While high levels of the first metric can indicate user's cognitive load associated with a certain area (longer fixations imply spending more time interpreting a certain element), a high value of the second one is generally interpreted as a sign of user's search problems [8].

3 Analysis of Results

Money-related skills. Out of six users, four users showed a good familiarity with adding monetary values during the game involving the real coins, whereas the remaining two users did not. In addition, no user seemed to have mastered subtracting monetary values when purchasing a product involving change while interacting with the real vending machine. As a result, out of six users, two were later asked to do the training with the Web application considering all the games (Task1 to Task4), whereas only two out of six users did not need to play with the "Sum" game (Task1).

Familiarity of use of real vending machines. As for their previous experience with real vending machines, all the participants reported previous experiences with real vending machines before the test (e.g. at school). However, no user had had previous experience with the vending machines that were used in the test. During the first baseline session, when users were asked to concretely do a purchase involving change by using the test vending machine, all showed difficulties with handling the change (i.e. correctly calculating it). However, no specific difficulty with interacting with the real vending machine was observed.

Figure 3: Errors made during the first and the second session

Interaction with the Web application. During the interaction with the web application, users had to perform a maximum of 4 tasks (as explained before). As it can be seen from Figure 2, task success slightly decreased only in Task 1, for Task 2 it remained the same across the two sessions, for Task 3 and Task 4 it improved. The number of errors decreased in the second session (see Figure 3), as did the time spent on the tasks, apart from Task 1 where it

increased very slightly during the second session. The efficiency slightly decreased for Task 1 and Task 4 (Figure 4).

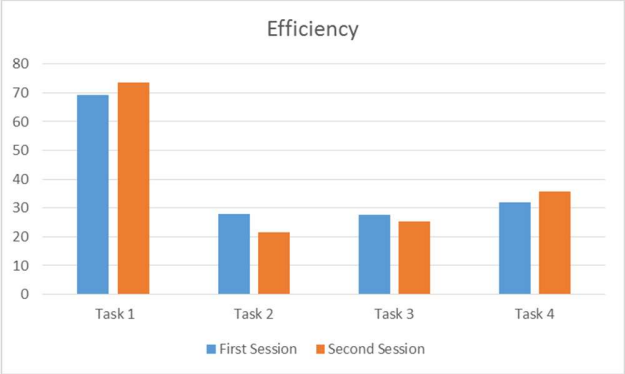

Figure 4: Efficiency level of the first and the second session

As for the data gathered through the eye tracker between the two sessions, the values associated with the second test are generally lower than those of the first one, which can be an indication of the fact that, as expected, in the second session users were more effective in identifying the areas needed to visit in order to complete the tasks. During the interaction with the 'virtual' vending machine, the evaluator noted that users had difficulties in properly detecting the number associated with each specific product: users did not expect that, in the Web application, in order to see that number, it was first necessary to select (i.e. click on) the product of interest (whereas in real vending machines it is generally permanently shown below the product). Another difficulty found was the fact that in the game there were two buttons, 'CONFIRM' (to actually purchase a product) and 'CANCEL' (to cancel the purchase it), which generally are not included in real vending machines where products are directly bought, without clicking on the 'CONFIRM' button.

Interaction with the real vending machine. During the interaction with the real vending machine, the main difficulties experienced by users were associated with making the involved monetary calculations (i.e. money change). Indeed, once users bought the product, and before they got the change from the machine, they were asked by the test moderator "You received the change of the money, do you know how much you will get?": this question was not easily answered by them and often the moderator had to help them with this calculation. Beyond that, in both test sessions users did not show particular problems with interacting with the real vending machine and with purchasing the expected products. By telling users which product to buy, they knew that they had to insert the money in the appropriate slot, and then they typed the corresponding number in order to have the product delivered. Thus, they apparently master this activity in real scenarios. However, the evaluator noted that they did not actually pay much attention to the price of the product to buy, as it seems that they rather 'mechanically' inserted the money in the vending machine, without first checking whether they had enough money to actually make the purchase (or, alternatively too much money). To confirm this, when the test evaluator explicitly asked them the price of the product, they answered the question with significant difficulty. In other words, it seemed that the cost of the product did not deserve much attention by participants. In addition, for two users, the code to type was slightly different across the two sessions (only numerical in the first session, alphanumerical in the second one - it depended on the product to buy): these users seemed to remember the type of code seen during the first session and then they somewhat expected the same pattern in the second interaction, and when it did not happen this was a bit confusing for them.

4 Discussion

During the interaction with the 'virtual' vending machine, the greatest difficulties seem to be connected with aspects that made the interaction with the 'virtual' vending machine even slightly different from real ones (e.g. having to select a specific product in order to get its price shown). This aspect can be interpreted as being connected with the well-known difficulties that people with autism find when coping with generalizations. Indeed, the involved test participants, in spite of having familiarity with basic mathematical calculations such as subtractions (the vast majority of them were attending high school, and one of them even completed it), and also having previous familiarity with both the real vending machines and PCs, when they had to carry out the same computational tasks in relation with handling money (e.g. using subtractions to get change), they showed difficulties not connected with the specific interaction modality used, but with such more conceptual aspects. This suggests that further training should be directed on addressing the difficulty of such individuals of applying the same concept (e.g. mathematical subtraction) in different domains. In addition, while apparently users were capable of performing purchases using a real vending machine in a real scenario, they nevertheless seemed to have not developed a deeper sense of monetary value, as none of them showed to sufficiently care about how much the product costed and whether the amount of money they had was adequate for the purchase.

5 Conclusions

The study can be useful for deriving relevant information for both improving the interactive training and also the kind of support that should be provided to ASD users to improve their independence in terms of money-related skills. For future work, it would be necessary to better focus on teaching the monetary value of things in a wider and deeper manner, pairing even more complex money-related literacy training, with regular opportunities for these people to autonomously experience and practice varying purchase experiences in different contexts of use. Moreover, further studies should investigate to what extent the use of different types of platforms/interaction modalities (e.g. touch-based mobile devices) could facilitate training of this class of users [9]. Finally, in next versions of the Web application we consider including automatic adaptation of the training provided to users according to their current level of money-related skills, to provide them with a more personalized and focused support.

REFERENCES

[1] S. S. Kapp, A. Gantman and E. A. Laugeson, 2011. Transition to adulthood for High-Functioning individuals with Autism Spectrum Disorders. University of California, Los Angeles.

[2] S. Tsikinas, S. Xinogalos (2018). Studying the effects of computer serious games on people with intellectual disabilities or autism spectrum disorder: A systematic literature review. Journal of Computer Assisted Learning, 35(1), 61-73.

[3] F. Curatelli, C. Martinengo, F. Bellotti and R. Berta, 2013. Paths for cognitive rehabilitation: from reality to educational software, to serious games, to reality again. Games and Learning Alliance, GALA 2013. Lecture Notes in Computer Science, vol 8605. Springer, Cham, pp. 172-186.

[4] S. Caria, F. Paternò, C. Santoro, V. Semucci, 2018. The design of web games for helping young-high functioning autistics in learning how to manage money. Mobile Networks and Applications (2018) 23: 1735.

[5] C. Friedman, 2017. People with disabilities' access to their own money. International Journal on Disability and Human Development, 2019;18(1).

[6] N. C. Cheak-Zamora, M. Teti, C. Peters and A. Maurer-Batjer, 2017. Financial Capabilities Among Youth with Autism Spectrum Disorder. Journal of Child and Family Studies (2017) 26: 1310.

[7] C.M. Peters, M. Sherraden, A.M. Kuchinski (2016). Growing financial assets for foster youths: Expanded child welfare responsibilities and caseworker role tension. Journal of Social Work, 61(4), 340. doi: 10.1093/sw/sww042.

[8] C. Ehmke, S. Wilson, Identifying web usability problems from eye-tracking data, Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI… But Not As We know It. Volume 1 (BCS-HCI '07), Vol. 1. British Computer Society, Swinton, UK, UK, 119-128.

[9] V. Gentile, A. Adjorlu, S. Serafin, D. Rocchesso and S. Sorce, Touch or Touchless? Evaluating Usability of Interactive Displays for Persons with Autistic Spectrum Disorders, Proceedings of The 8th ACM International Symposium on Pervasive Displays (PerDis '19). ACM, New York, NY, USA, Article 10, 7 pages.