Designing an Urban Support for Autism

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Abstract
This paper describes the preliminary results of a project aimed to support people with autism in finding city places that match their "sensorial" preferences and aversions. Through a participatory design approach, we designed an interactive map that collects sensorial data about the urban environment exploiting crowdsourcing mechanisms.

Author Keywords
Autism; crowdsourcing; interactive maps; orientation.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Autism is characterized by an atypical social functioning, with the tendency to withdraw from social interactions. Other peculiarities may affect the domains of communication, orientation, and executive functions [10]. Moreover, autistic individuals seem to react abnormally to common sensory experiences. Most of them are particularly and even painfully sensitive to sensorial stimuli of a certain intensity that are easily managed by neurotypical individuals (i.e., people who do not belong to the autistic spectrum) [16]. Symptoms may occur in different forms, ranging from mild or

severe intellectual impairments (individuals with mid- and low-functioning autism) to people with high-functioning autism/Asperger syndrome, who sometimes have an IQ above the average.

This paper describes the preliminary results of a project aimed at supporting people with autism in finding places that match their "sensorial" preferences and aversions by means of interactive crowdsourced maps. The project is framed within the cognitive urbanism theoretical background [12], which emphasizes that the features of human cognition interact with the characteristics of urban spaces to produce a subjective spatial representation of the city: it assumes that people with different cognitive (dis)abilities perceive, use, and live in urban spaces differently [15]. The novelty of the project lies in the attempt of understanding how individuals with autism "live" in urban environments from a "sensorial" point of view; as well as designing interactive urban maps that support them in finding places that may match their sensorial preferences.

Background

Computer-based support seems to be particularly useful for individuals with autism, as they show an affinity with technology [14]. A variety of research has leveraged technology to address specific problems that may characterize the autistic condition, like communication [3] and emotion [9]. However, the majority of these works focus on children [1], somehow leaving the needs of adults with autism unheard. A strong focus on social behavior problems, such as language production, emotion management, and social interaction, also led researchers to overlook other, equally relevant, difficulties that individuals with autism may face during their everyday lives. A significant domain that may have considerable impact on these people's daily activities relates to their way of perceiving the space in which they move and live. Albeit research hints to a superior performance of people with autism on visuospatial tasks (e.g., [7]), "many anecdotal reports from people with ASD [Autism Spectrum Disorder] and their carers actually attest to a difficulty with daily navigation and there are myriad accounts on internet forums of people with ASD being unable to find where they parked their car, or becoming lost in their hometown because a familiar route was blocked" [16]. Fornasari et al. [8] analyzed navigation and exploration of an urban Virtual Environment (VE) by children with autism in comparison to neurotypical children, finding that when freely exploring an unfamiliar VE, children with autism explore the environment less. Lind et al. [11] asked children with autism to find objects within a realistic VE, discovering that they show impairments in spatial navigation. Decker [7] interviewed adults with autism that further stressed their idiosyncratic urban needs for public transportation, training services, and access to health support. This line of research may suggest that persons with autism have peculiar modes of representing and using space, and they need to be supported during their daily movements across city environments.

Research on opportunities for technology to support the spatial needs of people with autism, however, is still limited. Exceptions are represented by Carmien et al. [5] who formulated requirements for designing human-centered transportation systems that are accessible to individuals with cognitive disabilities. Bozgeyikli et al. [4] investigated different locomotion techniques in Virtual Reality with users with autism. Boyd et al. [2] developed a system that increases the awareness of physical proximity in social contexts. Rapp et al. [13] preliminary explored the "spatial needs" of six adults with autism, finding that they have peculiar ways of representing the spaces in which they live. Building on top of this research, we investigate how people with autism sensorially perceive and react to the urban environment. No previous research has connected the spatial needs of individuals with autism to their sensorial preferences, as well as attempted to design a technological support for helping them find places that may match such preferences.

The design process

To achieve the project's goals we used different methods: qualitative interviews, cognitive maps, and participatory design techniques. These methods were chosen to capture the subjective perceptions and understandings of people with autism, in line with the cognitive urbanism approach we adopted. The design of the solution follows a user-centered design approach, whereby individuals with autism were continuously involved in the design process in order to understand their needs and define possible solutions. In the first stage of the project, we interviewed 12 persons with autism to collect their spatial and orientation needs. We involved six individuals with high-functioning autism/Asperger syndrome (autism level 1 according to DSM-5; average age=34.8; females=2) and 6 individuals with mid-functioning autism (autism level 1 and 2 according to DSM-5; average age=28.7; females=0), asking them to recount their everyday movements and everyday activities. Participants were invited to draw a map of the center of the city in which they lived, as well as of their home neighborhood, highlighting important landmarks and describing the routes that they habitually travelled. This activity was addressed to understand their mental representations of the urban space. Then, they were interviewed for one hour, being asked to describe their daily habits in terms of movements, use of means of transportation, daily task management. The findings were coded separately by two researchers, by taking apart sentences and by coding them with labels like "anxiety" or "problems in public transportations". Then, they assessed consistency in the application of codes. Inconsistencies were mainly related to discrepancies in labeling the same concepts (e.g., "anxiety" for the first researcher and "stressful situation" for the second one, which led to keep the former): all the inconsistencies were resolved. The resulting codes were grouped independently by the two coders, labeled and then compared again, yielding 13 learned abstracted categories. Axial coding eventually resulted into three axial categories, which pointed to the main "spatial needs" of individuals with autism.

Results of this phase of the research made led to the emergence of a variety of idiosyncratic needs with reference to space. In particular, all individuals with mid-functioning autism have scarce to no interest in visiting new places, traveling alternative routes, or exiting from their city boundaries. High-functioning/Asperger participants, instead, would like to visit new places. However, they often stick to the very same locations, due to the anxiety provoked by unexpected situations or the fear of feeling "unsafe". Actually, autistic individuals feel safe at home because they have control upon the environment. All the participants recounted to being sensitive to sensorial stimuli like light, sounds, smells, stressing the importance of finding places that are suitable to them when they are not at home.

In the second phase, we used Participatory Design (PD) techniques to involve the same five high-functioning/Asperger individuals who participated in the interviews (one participant refused). At this stage, we decided to focus on this population (high-functioning/Asperger), since the frequency, variety, and magnitude of their everyday movements entailed a more pressing desire to use technology for spatial support. During the design session, we offered them a concept of a map-based system which recommends "comfortable" spaces, as a basis of further discussion. The participants appreciated the idea of having a system where finding places suitable to them, but highlighted that recommendations would be more effective if suggested by other persons (rather than by algorithms), as they could better explain the characteristics of a given place. Moreover, they showed to be available to provide the information needed to populate the system. However, the idea of solely relying on the efforts of individuals with autism encountered a skeptical reaction, as their endeavors might not be sufficient to overcome the "cold start" of the application. Furthermore, the idea of relying only on people with autism might increase their desire to retreat in their communities.

In the third phase, we interviewed 20 individuals with high-functioning autism (average age=26.5; females=2; not involved in the previous phases) to understand what is a "safe" and "comfortable" place for them. Interviews lasted about one hour each and were audio recorded. They aimed to identify autistic individuals' preferences and aversions about outdoor and indoor places. They were analyzed through a thematic analysis as the interviews conducted during the first phase. By and large, results pointed out highly idiosyncratic preferences and aversions toward the urban environments, and that there are no places' characteristics that may reassure the entire population with autism. It also resulted that the most important "sensorial features" with reference to the urban environment are: crowding, noise, temperature, brightness, spaciousness, and odor.

A crowdsourced map

On the basis of the insights collected during the three research phases, we designed a crowdsourced system addressed to map places that could be perceived as safe by the autistic population. This map is populated with points of interest, trails, comments, and reviews, leveraging the contribution provided by autistic individuals and their caregivers, as well as anyone willing to improve the autistic people's lives. The user can insert a particular place in the map, by providing a short description, and by rating (from 0 to 4, using a slider) its i) level of noise, ii) level of crowding, iii) temperature, iv) level of brightness, v) spaciousness, vi) level of odor. Ratings have been chosen as an intuitive method to convey information about the sensorial features of the place and their degree of suitability to individuals with autism. The features have been selected on the basis of the findings collected in the third phase of the design process. Moreover, a global evaluation about the "comfort" of the place can be given, in order to convey information "in a glance" about the general suitability of that place to the autistic needs. The map is built on FirstLife, a "spatial" social network, based on OpenStreetMap. FirstLife is a flexible platform that can be adapted to different aims. It is composed of an interactive geographical map-based interface as a frontend and a backend aimed at managing and retrieving geographical data.

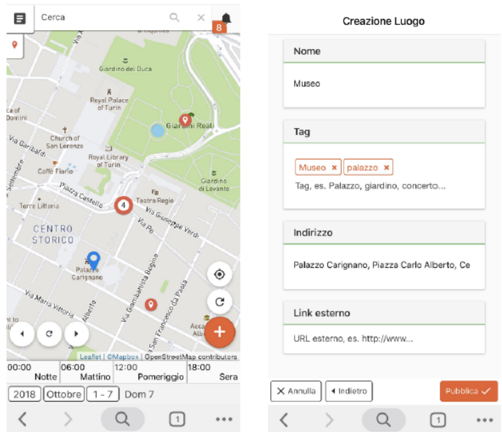

Figure 1. Screenshot of the crowdsourced map

Preliminary evaluation

We involved 8 individuals with high-functioning autism (autism level 1 according to DSM-5; average age=28.4; females=2) to preliminarily evaluate the acceptability of the designed service. Half of the participants used an iPhone to access the map, while the other half used a PC. The aim of the study was explorative and qualitative in nature. We neither collected quantitative measures, nor systematically evaluated the interface usability, as we were more interested in collecting preliminary qualitative data about the acceptability of the solution. All participants were relatively unfamiliar with crowdsourcing systems. All self-reported as Internet/PC/mobile users. None of the participants participated to the design process described above. The researcher first presented the system. Then, each participant could freely use it for as long as they liked, exploring its functionalities and contents. Then, the participants had to complete eight different tasks covering the different functionalities of the interface: finding a place by navigating the map, following a path on the map, creating a profile, inserting a new place, adding information to a place, modifying the information, canceling the place, reading a review provided by another user. The test lasted about 60 minutes. Participants gave feedback on the system in a thinking-aloud format. The researcher observed the interaction and documented the progress of each session keeping records of the participants' comments and difficulties. Results show that participants consider the system useful, namely that they would use it to plan their transfers and find places in the city they live. However, it emerged the need to personalize the system's interface as there were differences in the participants' capabilities of "reading" the map and its contents. Some participants appeared to suffer from a high cognitive load, mainly caused by the difficulties in visually distinguishing the places they inserted from those inserted by other users. Others were overwhelmed by the number of places visualized on the maps. This may suggest that we use different filters depending on the user's specific needs to reduce the "information load". Furthermore, some participants reported difficulties in understanding the point of view of other users when reading a review, being incapable of putting themselves in others' shoes. This may suggest that we use numbers and scales more prominently to communicate the "nature" of a place.

Conclusion and future work

This project represents a first step toward making our cities accessible to individuals with autism. In future work, we aim to evaluate the usability of the crowdsourced map and deploy the system "in the wild" in order to assess whether it can satisfy the needs of autistic people during their everyday transfers.

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