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## Web Accessibility Recommendations for the Design of Tourism Websites for People with Autism Spectrum Disorders

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**Abstract**—The universal Web design represents an ambitious and open challenge for the current research on the Web. Key aspects are Web accessibility and Web usability by people with the widest possible range of abilities, operating within the widest possible range of situations. Universal design is adaptive for the users, and provides personalised answers to different users. A recent study shows an estimation of the global burden of people with Autism Spectrum Disorders. In the last 24 years, the incidence of autism has a stable prevalence of 7.6 per 1000 or one in 132 persons. They represent a significant number of people. People with Autism Spectrum Disorders are usually solitary and visual thinkers and they could take advantage by the use of the Web. This paper discusses of tourism, website and people with Autism Spectrum Disorders. The aim is to define a set of recommendations for the design of tourist websites for people with Autism Spectrum Disorders, and to present a case study articulated in two tourist, autistic-friendly, websites. The first website considers the area of Rieti, central Italy; it has been validated through expert reviews, and several trials with many autistic, verbal users of a specialised centre for neurological and physical disabilities. The second website contains as a tourist destination the area around Mestre, close to Venice, Italy. In this case, the website has been validated on a single, non-verbal autistic user.

**Keywords**—Autistic-friendly website; Accessibility; Usability; Tourism; Autism Spectrum Disorders.

### I. INTRODUCTION

In this paper, we consider the problem of developing accessible and usable tourism websites dedicated to people with Autism Spectrum Disorders (ASD), and we extend some preliminary results presented in [1].

Web accessibility and usability represent an open challenge for the current research on the Web. They aim to make Web content more accessible and usable to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photo sensitivity and combinations of these [2].

Usually, Web developers apply general standards, following the guidelines provided by the World Wide Web Consortium (W3C) [3][4], without considering the importance of a universal Web access. However, every country supports the application of the Web Content Accessibility Guidelines (WCAG) 2.0 [2], although adopts a different Web accessibility legislation. WCAG 2.0 are recommended, but become mandatory only

in specific cases, such as, for example, in Italy, for the Web sites of public Institutions (see the so-called “Legge Stanca”, literally Stanca Act [5]).

In this paper, we are interested in the development of tourism, accessible and usable, websites dedicated to people with ASD. We thus first consider the relation between autism and tourism, and show the existing solutions for tour proposals to these specific users; then, we present the state of art of existing guidelines for the development of websites for people with cognitive disabilities, and extend them with new features specialised for people with ASD. To the best of our knowledge, there are no existing websites that are usable and accessible for people with ASD, and let them freely navigate inside them and take independent decisions (as, e.g., the choice of a tour). We thus propose an interesting case study of two touristic websites for autistic users and we show some experimental results on a set of 9 verbal users, and 1 non-verbal user.

The paper is organised as follows: Section II presents a brief description of the ASD; it is followed by Section III, dedicated to the state of art in autism and tourism. Section IV introduces the themes of usability and accessibility, which are deepened in Section V, where the discussion is specialised for users with cognitive disabilities; guidelines and related work are presented. Section VI revisits the recommendations for people with ASD. Section VII proposes our case study, focused on accessible and usable tourism, autistic-friendly websites. Finally, Section VIII describes the experimentation made with a group of autistic verbal and non-verbal users and the related results. Section IX ends the paper with a look to future work.

### II. AUTISM SPECTRUM DISORDERS

The American Psychiatric Association defines the ASD as neuro-developmental disorders with persistent impairments in social communication and social interaction, and restricted, repetitive patterns of behaviour, interests, or activities [6]. This general definition puts together people with a wide and different set of features and behaviours; so, it is difficult to create multi-purpose environments, but some general guidelines may be followed. We have focused our attention on ASD user profiles with the following features.

Typically, the impairments in social communication are related to *language delays*, however, people with ASD often present good visual abilities. Thus, modern speech therapies



are usually combined with Augmentative and Alternative Communication (AAC) techniques, i.e., powerful methods that combine different visual components in order to create syntactically and semantically correct sentences [7][8]. Among these AAC techniques a standard approach is to use the Picture Exchange Communication System (PECS), which promotes interactions among users with the exchanging of images [9]. People with ASD are usually visual thinkers, i.e., think in pictures and express their concepts by visualising sequences of pictures of the same object [10]. They have often *limited attention*, i.e., limited time in which they might be able to concentrate on a particular task, thus defining limited, self-contained tasks is very important. They might also suffer of *Sensory Processing Disorders* (SPD), and may thus feel distressed and confused in particular situations. SPD are neurological disorders that cause difficulties with processing information from the five senses (vision, auditory, touch, olfaction, and taste), as well as from the sense of movement (vestibular system), and/or the positional sense (proprioception) [11].

### III. AUTISM AND TOURISM: RELATED WORK

The UNTWO (World Tourism Organization) [12] recommends in several publications cited in [13], among the priorities for a global tourism, the accessibility of tourism websites. The numbers are not negligible. In a recent report in [14], ENAT (European Network for Accessible Tourism) indicates, only in Europe, a request for accessible tourism of 350 millions of people with different disabilities; more specifically, the global incidence of people with ASD is of 7.6 per 1000 (one in 132 persons) [15].

For people with ASD, some issues that have to be considered are: social inclusion, e.g., in community activities, emotional well being, e.g., happiness, interpersonal relations, e.g., friendship, and physical well-being, e.g., leisure [16]. All this, may be achieved with a well planned tourism trip, being it an experience that stimulates all the above domains. However, this is not trivial since all the different activities related to a trip, i.e., transportation, accommodation, etc. have to be adjusted to meet special needs.

The first issue that has to be considered is the preparation phase since it is well known that autistic people get stressed in unknown, unexpected situations, thus everything has to be previously planned, and the user has to be prepared to tackle each of the trip steps.

In [16][17] the authors identify some of the issues that a travel agency or whoever organises the trip should consider while planning it for an autistic user:

- *Survey phase:* A questionnaire should be provided in order to identify, which are the main physical, sensory, or language problems the user has, and which are his/her main interests. According to this, the agency can suggest suitable tourism destinations or trips. E.g., a person that gets stressed in very crowded, loud or noisy places should avoid amusement parks, crowded exhibitions, etc.
- *Trip planning:* At this point a trip may be planned by taking into consideration all the provided information. The first thing is transportation, so how to move from a home place to the destination. This can be achieved in different ways, what is important is that

all the steps are previously explained to the user. If the transportation is by air the airline company has to be contacted. Some airports offer some pre-planned visits of the airport [17], the airport of Dublin also offers some very interesting on-line material, which visually describes the different parts of the airport, following a logical sequence of actions, which a traveller is supposed to do. It also provides interesting tips on how to face all the different situations while being at the airport and also some general rules to follow during a trip [18].

- *Accommodation:* What seems to be more suitable for autistic users, are small size accommodations, such as small hotels and motels, or preferably the renting of a condo where the user can "feel at home". In the USA, there are some hotels that already provide "autism-friendly accommodations" with special rooms, staff, and meals [16].
- *Tours:* What concerns the tourism activities, is obviously based on the preference of the user. Thus, following the guidelines of the survey is a good starting point. Here, we have to distinguish between one day trips, which obviously have to be planned in the surrounding area, avoiding too much stress for the trip, and longer trips of two or more days. There are obviously different options, depending on the preferences and also considering the sensory problems, which autistic users might have. Possible options are sightseeing in scenic areas since autistic users often like silent places and love taking pictures, visiting historical and cultural sites, museums, aquariums etc. Some museums are "Autism-Friendly Museums", and are prepared to host these special tourists. An example is the Royal air force museum in London, which offers an autism friendly trail that can be downloaded from the site, and has won an Autism Access Award [19], or the Metropolitan museum of art in New York, which offers e.g., a social narrative (PDF) about visiting the Museum with tips, and a Sensory Friendly Map of the museum with the list of quiet and less crowded areas [20].

Obviously, general considerations are that first one should prepare the autistic user to very simple day trips, then these trips might be planned for a longer time. Daily activities should not be too intense, locations should be visited in times of the day during which places are not too crowded, i.e., stressful situations should be avoided as much as possible. A good idea is also to prepare the user for the changes of routine by illustrating the trip using brochures, photos, videos, etc.. A last consideration is that, often, things might not go as expected, thus the trip should be planned with flexibility in order to include last minute changes of planes, i.e., alternative destination, activities and so on.

The site Autistic Globetrotting is an example of a site developed for people with ASD (see [21]). It has the aim of encouraging families with people with ASD to travel around the world; it provides interesting hints for travelling, e.g., how to let a person with ASD pack his/her luggage, interesting destinations and hotels, and so on. It also states that the

benefits of travelling outweigh the problems one will face. For instance, travelling provides a hand on experience on some topics, which are studied in books at school (also people without ASD would benefit from it). Mathematics for calculating money exchange or tips, art by visiting museum and galleries, geography by physically moving from a city to another, literature by visiting homes of famous authors, and so on. It increases flexibility not only in the daily routine but also in the dietary restrictions by encouraging the experience of tasting different food, in the interaction with other people by enhancing social and language skills, in raising family bondings, etc.

#### IV. WEBSITE USABILITY AND ACCESSIBILITY

Access to information and communication technologies is a basic human right as recognised in the United Nations Convention on the Rights of Persons with Disabilities (CRPD) [22]. Disabilities might be either physical (visual, auditory, etc.), or cognitive and neurological, and they might be temporary or boundless.

The W3C [2][3] has proposed different guidelines to produce accessible websites; in 2012, a W3C group, named Web Accessibility Initiative (WAI), publishes a draft containing some principles of Web accessibility for people with cognitive or neuronal disabilities [23]; it marks the birth of a task force group, named Cognitive and Learning Disabilities Accessibility Task Force (COGA). Recently, in August 2016, COGA, together the Protocols and Formats Working Group, and the Web Content Accessibility Guidelines Working Group, have published a list of general guidelines useful for most people with Cognitive and Learning Disabilities [4].

However, specific features have to be considered while dealing with people with specific disabilities, such as ASD. As we have previously mentioned, typical problems that people with ASD face are limited attention, sensory hypersensitivity, different way of learning and reacting to things, problems related to limited text comprehension (e.g., not understanding figurative language, etc.). For such a reason standard usable and accessible websites might not be suitable for such users.

Web usability and accessibility are closely related and their goals, approaches, and guidelines overlap significantly [24].

Usability is all about designing an easy to use website that appeals to as many people as possible. websites should be intuitively usable. Usability is a *quality attribute* that assesses how easy user interfaces are to use; it is defined in [25] by five quality components:

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?
- Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

For Web developers, a key aspect of usability is following a User-Centred Design (UCD) process to create positive and emotional user experiences [26].

Accessibility is about ensuring an equivalent user experience for people with disabilities. For the Web, accessibility means that people with disabilities can perceive, understand, navigate, and interact with websites and tools, and that they can contribute equally without barriers.

Usable accessibility combines usability and accessibility to develop positive user experiences for people with disabilities. User-centred design processes include both techniques for including users throughout design and evaluation, and using guidelines for design and evaluation. UCD helps making informed decisions about accessible design. Thus UCD is necessary to improve accessibility in websites and Web tools.

The goal of Web accessibility is to make the Web work well for people, specifically people with disabilities. While technical standards are an essential tool for meeting that goal, marking off a checklist is not the end goal. People with disabilities effectively interacting with and contributing to the Web is the end goal [24].

We note that accessibility  $\neq$  usability. A website may comply with standards, may pass all the automated accessibility checks, may appear to be accessible, however, it is not necessarily usable. Web pages can be verified accessible by focus groups, and still be inaccessible to a third party. Individual users may have cognitive, technical, or other barriers.

#### V. USABILITY AND ACCESSIBILITY FOR PEOPLE WITH COGNITIVE DISABILITIES: GENERAL GUIDELINES AND RELATED WORK

The improvement of the quality of life for autistic people is a big and open challenge. Several studies recognise that the computer technologies are assuming a significant role for supporting the people with ASD [27][28][29]:

- They arouse the interest of these typology of users, that take major advantage from the interaction through devices with touch screens, such as tablets.
- They help them to develop their abilities and simplify some aspects of their lives.
- They represent a significant help for their families and therapists.
- The same research supports their effectiveness for people with ASD.

The computer technologies offer a large set of possibilities, such as websites, Web apps, affective computing, virtual reality, robotics, multitouch interfaces. In this paper, we mainly focus our attention on websites, and more in general, Web-based applications, since they play a major role in content display both for online and offline use, becoming more accessible with time, and giving the possibility to develop tools that easily meet users needs. Web sites, Web applications, and multitouch interfaces to the Web technologies assume a strong role on the basis of the following considerations [1][30]:

- They are within the reach of all.
- They do not need of specific pre-expertise in their use.
- They do not have elevated costs.
- They play a major role in content display both for online and offline use.
- They are becoming more accessible with time, cancelling the gaps among people, without discriminations.

- They may offer easy and fast customisation.
- They evolve in the time with the new Web standards, tackling problems that are typically linked to more traditional monolithic applications.

An interesting reading [31] is provided by Jamie Knight, autistic developer and senior accessibility specialist: he discusses on cognitive accessibility and provide some practical guidelines.

However, in the last ten years, some works [1][4][27][29][32][33] have been dedicated to define a formal set of guidelines for designing usable and accessible user interface for people with cognitive disabilities:

- In [32], the authors propose a review of the previous literacy and extract a list of 64 recommendations for people with cognitive disabilities, including ASD; only four of them have a frequency of citation, in the revised works, at least 50%. They are:
  - 1) Use pictures, icons and symbols along with text (75%).
  - 2) Use clear and simple text (70%).
  - 3) Consistent navigation and design on every page (60%).
  - 4) Use headings, titles and prompts (50%).

The four recommendations can be regrouped in three macro-areas: language (items 1, 2), structure and navigation (item 3), and graphical layout (item 4).

- The recent report [4], cited in Section IV, identify detailed techniques that should enable content to be usable by people with cognitive and learning disabilities. They may be grouped in the following main macro-areas:
  - 1) Provide a clear structure.
  - 2) Be predictable.
  - 3) Use a clear writing style.
  - 4) Provide rapid and direct feedback.
  - 5) Include help meaning.
  - 6) Use a clear design.

The six recommendations can be regrouped in same three macro-areas: language (items 3, 4), structure and navigation (items 1, 2, 5), and graphical layout (item 6). The macro-area no. 5 suggests the importance to include short tooltips on all icons, jargon; to introduce charts and graphs; to use symbols and images to show meaning [4].

- In [29], the authors analyse the previous literacy between 2005 and 2015 and identify 28 guidelines, specific for people with ASD; then they distribute them in the ten categories (deeply discussed in the cited paper [29]): four of them represent critical interface design aspects, according to the number of extracted recommendations and number of works from which the authors extracted the recommendations:
  - 1) Visual and textual vocabulary.
  - 2) Customisation.
  - 3) Engagement.
  - 4) Redundant representation.

The 4 recommendations can be regrouped in the same three macro-areas: language (item 1), structure and navigation (items 3, 4), and graphical layout (item 2).

The Web Content Accessibility Guidelines, WCAG 1.0 and WCAG 2.0 [2] represent the international standard reference model in this research domain. However, different practical and operative guidelines have also been proposed [31][34], together to some systematic studies [27][29][32][33].

Given that most of them consider similar aspects, we have analysed and summarised all of them in the following three macro-areas:

*a) Graphical layout:* Users with ASD may easily be distracted by secondary contents, thus webpages should be very simple and should not contain information, images, frames that create distractions. The page layout should be consistent throughout the website. Images and white space should be copiously used in order to focus the user attention and to simplify the concepts absorption. Background sounds, moving text, blinking images and horizontal scrolling should be avoided. Attention must be paid to fonts and colours: words should be easily readable, thus should usually be written in plain Sans-serif fonts (e.g., Verdana) of at least 12 points. To emphasise words, bold should be used. The choice of the right color is very important, people with ASD may avoid the navigation in sites with particular predominant colours, e.g., red. Foreground and background colours should have sufficient contrast but not too much, some ASD users find e.g., that black on white, is too visually stimulating.

*b) Structure and Navigation:* The website should have a simple and logical navigation structure, links should be easy-to-access and to find, and few options should be given in order to avoid the user confusion. The navigation inside the site should be limited by three clicks. Each page should contain the navigation information and navigation buttons at the top and the bottom of the page.

*c) Language:* The language should be simple and precise so that it does not create ambiguity, secondary and irrelevant information should be avoided. The text should be short and self-contained. The words should refer to things that "can be seen", acronyms and abbreviations, together with non-literal text, and jargon should not be used since people with ASD literally interpret the text content.

## VI. SPECIALISING THE GUIDELINES FOR AUTISM

The three macro-areas proposed in previous Section V define a set of general recommendations; in this section we specialise them, integrating new features, specific for the ASD characteristics:

*Graphical layout:* Limit the text to very few, simple sentences, and add many images in a PECS-like style in order to describe concepts and actions through sequences of images. This is the most important feature, i.e., the copious use of images throughout the site, in order to transmit all messages. Repeat concepts, and in the homepage write a sentence that let the user feel it navigates in its "own" site. Write sentences in bold, of big size and uppercase.

*Structure and Navigation:* Use simple and sketchy symbolic pictures. If the site is directed to a group of young users, add, when possible, some simple games to involve the user, and also to check his/her level of attention.

*Language:* Use simple and minimal sentences, and illustrate concepts through images, and not through the written text.

To summarise, the main feature that we think should be added is the use of many figures to explain situations, illustrate

actions, etc. This choice is based on an Augmentative and Alternative Communication (AAC) approach that is widely used to improve standard communication. Moreover, we enforce the involvement of the user on the site navigation by adding sentences that personalise the site, and by adding games that increase his/her curiosity. As we will describe in Section VIII, this choice has been proved to be winning in our testing phase.

## VII. OUR CASE STUDY: *ScopriRieti* AND *ScopriMestre*

There are sites that provide tourism destinations for people with ASD, or that give some tips on how to develop an autistic-friendly website, however, we could not find sites whose aim was the independent (or almost-independent) planning of a trip by a user with ASD.

In this section we propose two tourism websites developed for a target group of young people/adolescents. The first site, called *ScopriRieti* (literally, “Discover Rieti”) [35], has first been proposed in [36]. It is an autistic-friendly site, that the user may use to simply search information, or, what is more interesting, to independently choose one among different possible destinations of a one-day tourism trip in the neighbourhood of Rieti, an Italian town in the north of Rome. This site has been developed for verbal young/adolescents people with ASD. The second site, called *ScopriMestre* (literally, “Discover Mestre”) [37], has recently been developed for a tourism tour around Mestre (a city close to Venice), and it is a simpler version developed for non-verbal young users with ASD.

While developing both sites, we made sure that they met all the accessibility and usability standards we have presented in Section V and Section VI. We first developed the *ScopriRieti* website in collaboration with therapists and operators of the centre Nemo in Rieti, which hosts different users with neurological and physical disabilities. Following the same guidelines we then developed a similar, simplified version, the *ScopriMestre* website.

### A. The website structure of *ScopriRieti*

We will first introduce in detail the *ScopriRieti* website, the *ScopriMestre* website will have a similar structure, in the next section we will point out the main differences.

**Graphical layout.** The page layout is essential and simple in order to be enjoyable and comprehensible. The background is white and it has just some simple bars in a flexible colour (blue and orange), in order to avoid too much contrast on the colour, and thus prevent visual discomfort. The header of the website contains typical standards such as the logo, the primary navigation menu and the search bar, as shown in Figure 1.

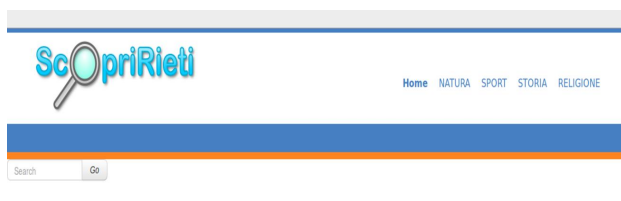


Figure 1. The header bar of our website. The menu contains four main items: nature, sport, history, and religion.

We have inserted many pictures and photos in order to increase the full comprehension of the site content, which is

simple, repetitive and synthetic. We have also followed the guidelines and the suggestions proposed by the therapists, and we have included travel itineraries that well suited the users. In the homepage we have written a sentence “Sei un ragazzo del Centro Nemo? Questo sito è stato realizzato proprio per te” (Translation: “Are you a girl/guy of the Nemo center? This site has been developed for you”) that would let the user feel happy to navigate inside his “own” site.

We have used simple fonts, big size and uppercase for letters in order to facilitate the reading (see Figure 2. Translation: Discover several new places of Rieti and organise a tour with your friends or your family. What do you like?).



Figure 2. The fonts.

**Language.** The language used is simple, sentences are minimal and do not contain acronyms or abbreviations (see, e.g., Figure 2). Note that, the site is in Italian since it had to be accessible by Italian disabled users. We have preferred to illustrate all the tourism experience with a sequence of pictures, rather than with some text (see the entire home page in Figure 3). This prepares the user with ASD to a sequence of practical experiences and actions, which he/she has already visualized and pre-processed, and thus reassures him/her.



Figure 3. The homepage.

**Structure and navigation.** The site is organised in at most four levels. From the logo, the user can go back to the homepage. In some pages, there is a back command. We have not included pop-ups in Javascript, background sounds, moving images in order to avoid sensory annoyance.

The user may navigate from the homepage to the secondary pages by clicking (a) on the images or (b) on the green smiles below, or from the main menu in the header (see Figure 3).

We have discussed with the psychologists, and opted for the use of simple and sketchy symbolic pictures. The idea is that if a user with ASD sees a picture with a bike inside a bike trail (see Figure 4) s/he will conclude s/he can practice this sport.



Figure 4. A bike trail tour.

In the homepage, the user faces a decision “Cosa ti piace?” (“What do you like?”), and has to choose one of the four itineraries, each of one has the same structure and contains: a simple question, an image that represents the general content of the page, links to pictures, videos, four images that link to subsections, which include information on where it is located, how we can go there, what can we do there, and what to bring (see Figure 4). All these links can be used to prepare the user to the trip by visualising in advance a map of the location, the way the trip will be done (by car, by bus, with relatives, etc),

how to behave, and what to see. The last link, a backpack, contains instructions on how pack it and what to bring on that specific itinerary (see Figure 5).

## NELLO ZAINO PRIMA DI PARTIRE: PREPARA LO ZAINO

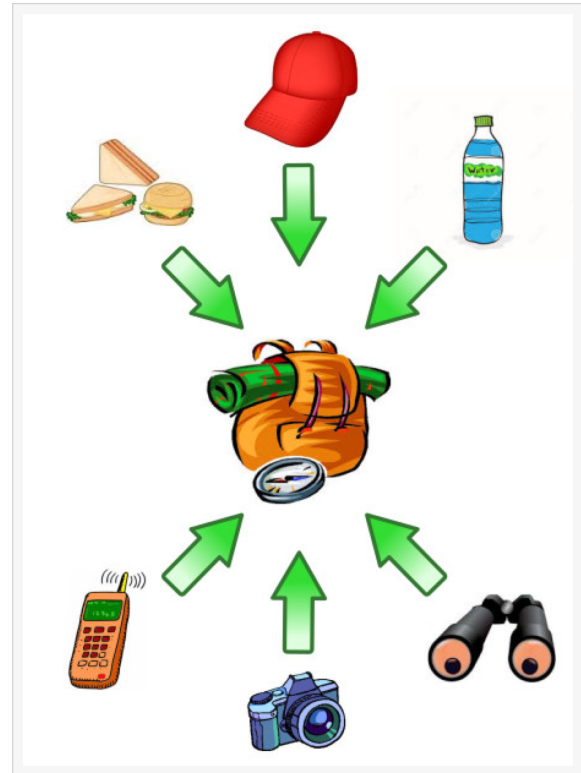


Figure 5. What to bring in the backpack.

Some sections contain some games, in which we can check the level of attention of the user. There are questions as: “Have you seen this image during the itinerary?” and so on (see Figure 6).

Finally, at the end of most of the pages we can find a print command (“stampa la pagina”) and a back command (“torna indietro”), see Figure 7.

*Itineraries.* We have chosen four possible itineraries, for a one day tourism trip in the neighbourhood of Rieti and the options are: nature, sport, history, and religion. These topics, well fit these users since people with ASD like to explore quiet and relaxing places (nature and religion), love to move around (sport), are very good at memorising dates and images, and often like to take pictures (history). As we will mention in Section VIII, all these itineraries have all been very much appreciated by the users of the experimentation.

All these itineraries can be done in one day, having as a starting position the centre Nemo, and given that some are urban tours we have pointed out known places inside town to facilitate the comprehension of the destination location.



Figure 6. A partial screenshot of the game, Sì, No (literally Yes, No).



Figure 7. A print and a back command.

### B. The website structure of ScopriMestre

The structure of this new website is very similar. We have chosen the same graphical layout, fonts and colors, structure and navigation. However, given that our experiments had to be run on non-verbal users, we added as a general requirement additional simplicity in the site presentation. In particular, the main differences between the two sites are:

- *Language.* Given that the users are non-verbal we have decided to use very few short sentences and many pictures, i.e., a simplified language compared to the one of the ScopriRieti website.
- *Itineraries.* We have chosen four possible itineraries, for a one day tourism trip in the neighbourhood of Mestre and the options are: nature, sport, parks, and culture (see Figure 8).

Given the strongest disability of the new users (they are non-verbal) we have decided to replace more complicated itineraries such as religion and history with parks and culture. In particular, for the itinerary in the nature we have chosen a one day trip along the Sile river, close to Treviso, for sport a trip along the

**SEI UN RAGAZZO DI MESTRE? QUESTO SITO È STATO REALIZZATO PROPRIO PER TE!**  
SCOPRI TANTI NUOVI POSTI DI MESTRE E ORGANIZZA UNA GITA CON I TUOI AMICI O CON LA TUA FAMIGLIA!



Figure 8. The homepage of the ScopriMestre website.

cycling path of Forte Gazzera in Mestre, for parks, a one day spent in the San Giuliano park of Mestre, the biggest of Europe, finally, for culture we have planned a trip to Venice.

- *Page content and navigation.* We have simplified the explanation of the itineraries and page content, see e.g., Figure 9 where we have used two simple sentences and a single image.

ScopriMestre > SPORT > COME COMPORTARTI

### COME COMPORTARTI

INDOSSA SEMPRE IL CASCO



Figure 9. A simple page of the ScopriMestre website.

We have also omitted the part on games, since the games require at least some basic verbal language and some non trivial-level of content comprehension. Finally, we have chosen videos animated by the cry or movement of animals or by activities on water, which are usually liked by people with ASD.



## VIII. EXPERIMENTAL RESULTS

In this section we describe the methodology we have used and we then illustrate our experimental results first on the ScopriRieti site [35], and then on the ScopriMestre site [37].

### A. Methodology.

The development of the both websites has followed different steps:

1) *Collection of medical material*: The first phase was the search for the medical material on the specific disability, and the study of the characteristics that define these specific users. This is important both to well meet the accessibility requirements, and for the choice of the appropriate content for the site.

2) *Literature survey*: In the second phase, we have collected all the information about usable and accessible websites for users with ASD, and we have proposed some new interesting features that the site should include (e.g., pictures, games, etc.).

3) *Interviews*: In the third phase, for the ScopriRieti site, one of our group members (Elisa) has interviewed a group of specialised therapists and professionals of the centre Nemo of Rieti, Italy. This centre hosts people with different neurological and physical disabilities. Elisa has collected information about the different disabilities and about the limits and expectations one could meet while developing the site. She has also participated to different meetings in order to analyse the methodology used by the professionals for approaching these users. What we have realised in this phase is that the site had to be developed for users, which were not "too much serious", given that it is not easy to include users with big behavioural problems in tourism activities outdoor. Thus, we have developed our site for users with non-serious or mild disabilities, that had some elementary ability with the use of a computer and with reading. In the case of the ScopriMestre site, we have discussed with a specialised operator what to change to the previous structure, so that the site could be enjoyable by non-verbal users with ASD and with non-serious disabilities. We have thus decided to mostly simplify the language shortening many sentences, and we have proposed very simple itineraries, which are very well known by all the people living in Mestre (and probably by all the autistic users that will navigate on the site).

4) *Website development*: The forth phase was the development of the website applying the four categories of guidelines (discussed in Subsection V and in Section VI), and the hints and suggestions collected in the two previous phases.

5) *Preliminary test on a single user*: The fifth phase was a preliminary test on a single user. We wanted to ensure that the site had been appropriately developed and was comprehensible. We have collected the impressions both of the user and the therapist that was following the meeting. We have thus accordingly adjusted and improved the site.

6) *Test on a group of users*: In the sixth phase, for the ScopriRieti site, we have then presented this new version to a wider set of users, which were first instructed, and were then left free to navigate and explore the site. We have then collected their impressions. In that case of the ScopriMestre site, for lack of time, we have tested the final site only on the same single user. However, although this site has still to be tested on more users (this is left as future work), as we will see in Section VIII-B, the results on a single user were still very interesting. In this case, given that the user was non-verbal, we have collected the impressions of two distinct operators that separately, and during different sessions, followed the test on the user.

7) *Assessment questionnaire*: In order to evaluate the perceived accessibility of the Web site, in the last phase we collected the impressions from the relatives of the users by an assessment questionnaire.

### B. Outcomes of the tests and of the assessment questionnaire for the ScopriRieti site.

We first present the results for the ScopriRieti and then for the ScopriMestre site.

We have tested the ScopriRieti site with a set of 9 users (1 female and 8 males) with non-serious or mild disabilities, with different backgrounds and general expertise, with some computer skills, and with some interest on this touring activity.

1) *Disabilities*: Our 9 users (whose names have been omitted for privacy reasons) had the following disabilities:

- U1 (19 years old), U2 (18 years old), and U3 (18 years old)  
ASD and medium mental retardation;
- U4 (19 years old)  
ASD and mild mental retardation;
- U5 (14 years old), and U6 (15 years old)  
Asperger syndrome;
- U7 (22 years old) ASD and psychosis;
- U8 (15 years old)  
medium mental retardation
- U9 (17 years old)  
mild mental retardation.

We have excluded from this group users with serious mental disabilities.

2) *Computer skills*: All the users had some basics skills on how to use the computer. Depending on the skills, we have left the users to either autonomously navigate, or we have partially helped them. Some have been able to type the name of the site, others have found it already opened. We made sure that could navigate without external distractions.

3) *Test results*: We have tested the Web site with one user at a time with the goals of completing three simply tasks:

- Task 1: Autonomously navigate in the Web site.
- Task 2: Autonomously choose a typology of itinerary.
- Task 3: Complete the test.

In the following, we describe the test results for each user:

- User U1 has shown very good computer skills; she was able to autonomously navigate inside the site; she has chosen the historical itinerary, and has navigated inside it in a non sequential way, being intensely involved. She has spent a lot of time looking at pictures and videos.
- User U2 was able to autonomously navigate; he has shown interest for the religious itinerary, and, in general, for the preparation of the backpack in all the different itineraries.
- User U3 was almost independent in the navigation phase. He chose the historical itinerary, and got so involved by looking and photos and videos and completed the test saying "I want to go there!". He really liked the proposed games.
- User U4 has navigated inside the sport section; he has intensely observed pictures and videos, and has autonomously discussed, which places he had already explored, and which were new.
- User U5 has shown very good computer abilities. He has chosen the historical itinerary, and has explored it following the sequential sequence, observing all the pictures, and enthusiastically playing the proposed games.
- User U6 had more difficulties on the use of the computer; thus he had found the homepage open. He has chosen the naturalistic itinerary, which he had already visited with the school. He has intensely observed all the pictures, and declared that he wants to go back there with his family.
- User U7 has chosen the religious itinerary; he was very curious about all the churches and saints (he did not know about), thus asking many questions during the navigation and observation of the photos.
- User U8 has chosen the naturalistic itinerary. He was not very skilled in the use of the computer, thus followed some verbal suggestions. He was enthusiastic about the pictures of lakes, plant and animals. We are not sure whether he has really understood all the information, as, e.g., the location of the lakes.
- User U9 has chosen the historical itinerary; he was enthusiastic about the pictures of the underground trail and has declared he wanted to do it soon. Even in this case he needed some verbal help, and we are not sure he has completely understood all the information collected during navigation.

Table I synthesises the number of tasks realised by each user.

To summarise and provide a quantitative metric, we considered the task *completion rate* - *cr*, that represents one of main metrics used to evaluate the effectiveness of a Web site, that is, the accuracy and completeness with which users achieve specified goals.

$$cr = \frac{\text{Number of tasks completed successfully}}{\text{Total number of tasks undertaken}} * 100\%$$

This metric is recommended by the ISO/IEC 9126-4 Metrics [38]. In our test, each user had to complete three main tasks.

TABLE I. Only user U6 was not completely able to complete one of the three tasks.

User	Task 1	Task 2	Task 3
U1	Yes	Yes	Yes
U2	Yes	Yes	Yes
U3	Yes	Yes	Yes
U4	Yes	Yes	Yes
U5	Yes	Yes	Yes
U6	No	Yes	Yes
U7	Yes	Yes	Yes
U8	Yes	Yes	Yes
U9	Yes	Yes	Yes

Applying the results showed in Table I, the task completion rate is strongly positive.

$$cr = \frac{26}{27} * 100\% = 96.3\%$$

All the users, except a couple of them, had previous navigational experience on the Web, and were able to follow the itineraries and to use the mouse.

Figure 10 shows the percentages related to the chosen itineraries.

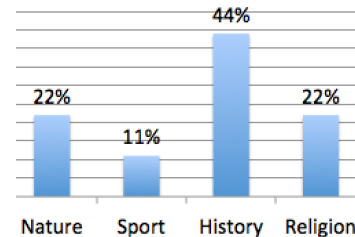


Figure 10. The typologies of chosen itineraries.

All the users were enthusiastic, and have really liked the site and all the itineraries. In particular, the elements they have preferred are: the pictures, an explanation on how to prepare the backpack, the proposed games. All of them have also asked questions about specific pictures, have discussed the site contents, and some of them really wanted to try the real itinerary right away. The use of the mouse facilitated the navigation. We also tried to run the tests using touch screens, but this seemed to complicate it.

As a limit, we have found that some users have shown some small difficulties on finding the location of some specific pictures, and on the sequences of some itineraries.

4) *Assessment questionnaire*: We have finally proposed an assessment questionnaire to the families. We have first met them and we have illustrated and shown the Web site. Some of them had already seen it previously and had given suggestions on its development. The families were asked to fulfil a questionnaire of 7 items, focused on four constructs, extracted and adapted from [39]: graphical layout (GL), structure and navigation (SN), language (LA), satisfaction (SA).



The levels of agreement were expressed by a 5-point Likert scale ("completely disagree", 5: "strongly agree").

Table II shows the 7 items.

TABLE II. The 7 items of the questionnaire

Construct	Item
01-GL	Accessible and easy graphical layout
02-LA	Accessible and easy language
03-SN	Accessible and easy structure and navigation
04-SA	Easy to use
05-SA	Autonomous choices
06-SA	Satisfactory content
07-GS	Future use of the Web site

Figure 11 shows the results of the questionnaire, and for each statement, relatives' ratings as well as their mean ( $\mu$ ) and standard deviation ( $\sigma$ ).

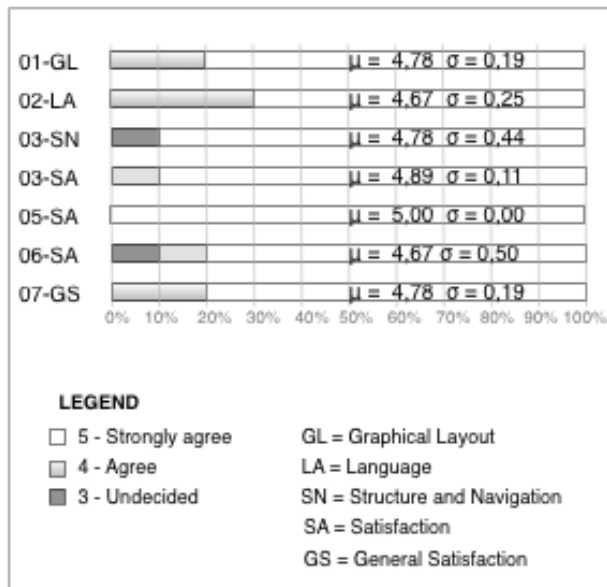


Figure 11. Relatives' assessment questionnaire results.

This project and the Web site have been really appreciated and the parents have claimed they will surely use it for future trips ( $\mu=4.78$ ,  $\sigma=0.19$ ), since relatives were happy to have a site where their kids could "autonomously navigate". What emerged is that some of the itineraries were known, others were new. Parents really liked the section on the preparation of the backpack, and the indications on how the trip evolves in order to stimulate their kids orientation capabilities. The site has been appreciated in all the three main components: graphical layout ( $\mu=4.78$ ,  $\sigma=0.19$ ); language ( $\mu=4.67$ ,  $\sigma=0.25$ ); structure and navigation ( $\mu=4.78$ ,  $\sigma=0.44$ ). It has been considered easy to use ( $\mu=4.89$ ,  $\sigma=0.11$ ); in the opinion of the parents, the objective to sollecitate autonomous choices has been completely reached ( $\mu=5$ ), and content has been considered satisfactory ( $\mu=4.78$ ,  $\sigma=0.19$ ).

### C. Outcomes of the tests and of the assessment questionnaire for the ScopriMestre site

We have tested the site on a single user  $U$ , and we now illustrate the results.

1) *User*: We have tested the site with one non-verbal male user of 10 years old, with autism and a limited level of comprehension.

2) *Computer skills*: The user  $U$  had some basics skills on how to use computers/smartphones/tablets. In particular he had very good abilities on how to navigate on YouTube, but needed help to open specific pages (e.g., the main page of the ScopriMestre site).

3) *Interests*: The user  $U$  had some general interest on this touring activity.

In the development phase we have tested the site on the user, and noticed that only few changes were necessary in order to improve the presentation of the photo galleries. The rest of the site well suited the user.

4) *Test results*: We have started a formal test of the ScopriMestre site with the user  $U$  first with operator  $A$  and then with operator  $B$ .

a) *Results with operator A*: Operator  $A$  tested the site both on a computer and on a smartphone. User  $U$  needed some help during navigation, in particular he had to found the homepage open. He chose the sport itinerary all the times, by pointing it with his finger on the computer, or by independently choosing it with a smartphone. He intensively observed all the pictures, and videos, and tried to navigate also on the other itineraries.

b) *Results with operator B*: Operator  $B$  tested the site with  $U$  both on a computer and on a iPad. Even in this case user  $U$  needed some help to start the navigation from the main page, and he was then able to autonomously navigate inside the site using the iPad (with the computer needed some help). He again chose the sport itinerary and decided to first navigate on pictures and then to view the video.  $U$  also showed interest in the pictures related to the preparation of the backpack. He did not show much interest on the maps, because this requires some kind of concept abstraction level. The only exception was the map of Venice, since it is a real photo taken from an airplane. He also liked the pages on "what you can do" on the itinerary or "how you should behave". As a second itinerary  $U$  chose nature, then culture, then parks. Finally, operator  $B$  noticed that  $U$  preferred the video related to culture, which is an accelerated video, compared to the normal speed one.

To summarise the result, from the opinion of both operators  $A$  and  $B$  (since  $U$  is non-verbal and is not able to write), the user was able to complete the test up to the end. What also surprised both operators is that he was able to understand the symbolic pictures of the itineraries, at least the one used for nature and sport. User  $U$  was enthusiastic, and really liked the site and all the itineraries (in a scale of 5, 5 out of 5). With user  $U$  touch screens worked better than the computer with mouse.

As a limit, we have found that user  $U$  has shown some small difficulties on the use of the back command, and needed

some initial help before understanding how it worked.

5) *Assessment questionnaire*: We have finally proposed the assessment questionnaire to the family of user *U*, after we have met the parents to illustrate the site. As for the case of the ScopriRieti site, this project and the ScopriMestre site have been really appreciated. What emerged is that all itineraries were known. Parents really liked the idea of letting the user choose a preferred itinerary. They also found useful being able to show the site to prepare their kid before starting the trip, given that users with ASD decrease the stress when they know in advance what they will be doing. Globally, the site has been really appreciated both for the contents and for its graphical design (in a scale of 5, 5 out of 5). What the parents suggested is to eventually add some sub-itineraries inside a single one, in order to have multiple options.

#### IX. CONCLUSION AND FUTURE WORK

In this paper, we analysed how an accessible and usable website should be developed in order to be enjoyable by a user with ASD. We have also considered, how such a user can benefit of travelling around the world, and which tips it should follow in order to be able to face in serenity the trip. We have finally presented two interesting accessible and usable websites we have developed for users with ASD, the first for verbal, the second also for non-verbal users. With these sites, the users were able to plan and almost independently decide the trip they wanted to do. We have also shown the appreciation results it has received while experimented on a group of users with ASD. This work represented a pilot, prototypal project and the encouraging feedbacks allow us to plan future work:

- Extend the test on the ScopriMestre site to a wider set of users (results on a single users were very encouraging).
- Validate the usability and the accessibility of the websites on a *systematic analysis of data collected on a statistically significant sample* of users. This will require: (a) the creation of new websites that will use our conceptual model; they will contain as case study other cities; (b) the definition of the features of potential user profiles, in order to generating a taxonomic analysis of the experimentation results.
- Implement a *mobile app*, that will contain all the case studies and will become a concrete tool for the tourism; it should be an adaptive and ubiquitous app able to follow the users on their trips. We will collect all the information generated by the use of the app, like navigation paths, user profiles, user preferences, geo-localisations, etc.; the aim will be to analyse these data and define a reference model for an adaptive, and semantic app for the tourism of specific class of users.
- Implement the *social aspects*, in such a way users could vote their preferred pages, insert a personal comment or share their trips and their experience.

#### ACKNOWLEDGMENT

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