Techniques and Recommendations for the Inclusion of Users with Autism in the Design of Assistive Technologies

ABSTRACT The increasing numbers of technology platforms offer opportunities to develop new visual assistive aids for people with autism. However, their involvement in the design of such aids is critical to their short-term uptake and longer term use. Using a three-round Delphi study involving seven Australian psychologists specializing in treating people with autism, the authors explored the utility of four techniques that might be implemented to involve users with autism in the design process. The authors found that individual users from the target group would be likely to respond differently to the techniques and that no technique was clearly better than any other. Recommendations for using these techniques to involve individuals with autism in the design of assistive technologies are suggested.

KEYWORDS assistive technology, autism, design process

INTRODUCTION

People with autism spectrum disorders have long been considered to be highly visual (Kamio & Toichi, 2000), and for some time visual tools have been used to assist them in many facets of life. For example, visual tools have been used to assist children with autism to develop speech and to enhance social behavior (e.g., the Picture Exchange System [Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002]), to reduce aggressive and disruptive behaviors (e.g., the Picture Exchange System [Cafiero, 2001]), to reduce fears about future events (e.g., visual social stories [Gray & White, 2002]), and to enhance their play (photographs and textual prompts [Krantz & McClannahan, 1998; Libby, Messer, Jordan, & Powell, 1996]). However, such tools are often paper-based and bulky and may be unacceptable or impractical in many contexts.

In parallel with the increasing availability of suitable handheld platforms such as personal digital assistants and mobile telephones over the past 15 years, there has been a trend to develop aids based on digital technologies that are more discrete and socially acceptable. Here we refer to this group of supports as “digital assistive technologies” to distinguish them from the parent classification of assistive technologies.
Assistive technologies in general, however, have a history of problems in their adoption and continued use. For example, Kintsch and dePaula (2002) report that one third of all assistive devices are abandoned primarily because there is a lack of user input into the selection and design of such devices. This is particularly relevant when the target group is conscious of being “different” and has indicated that it wants to be consulted (Hurlbutt & Chalmers, 2002). User involvement in selection and design is, then, a key factor in the adoption and continuing utilization of assistive technological devices, and Hurlbutt and Chalmers (2002) advocate strongly that user-centered and participatory approaches be adopted in the design process for people with autism, especially those who are high functioning. Further, opportunities for user input into the design of all assistive technologies should go beyond functionality and into preferences and designs, as devices “must be aesthetically pleasing, age appropriate, fashionable, and culturally and socially acceptable” (Kintsch & dePaula, 2002, p. 6) Devices that look “handicapped” are unlikely to be adopted (King, 2003; Nielsen, Clemmensen, and Yssing, 2002). We believe that designers of digital assistive technologies must likewise include users, and their wants and needs, as far as possible in the design process if the maladoption experiences of nondigital assistive technologies are not to be perpetuated.

Technology designers have employed a range of techniques to better understand users or engage them in the design process. For example, Brun-Cottan and Wall (1995) suggest that “video” can be used to record users at work and during design meetings, and then replayed to users for verification and discussion. Crabtree et al. (2002) proposed a technique, called “cultural probes,” in which participating users are provided with a “kit” containing a camera, voice recorder, a diary, and postcards, allowing them great freedom and control over what they reveal to themselves to the researcher. Likewise, Hutchinson et al. (2003) made a valuable extension with “technology probes,” which are devices that are left with users to stimulate them to imagine functions. The devices can be equipped with a facility to record a history of operation to enable designers to review use.

Nielsen, Clemmensen, and Yssing (2002) described the “thinking aloud” technique. Although commonly employed in usability testing of newly developed systems and devices, it seems appropriate that it be considered when determining how the user interacts with current systems and understanding the thoughts of the user. Similarly, “role play” provides the user an opportunity to give a potential device form and function in a highly contextual way. Role play techniques include “acting out” (Howard, Carroll, Murphy, & Peck, 2002) and the use of improvisational theatre (Brandt & Grunnet, 2000; Kuutti, Iacucci, & Iacucci, 2002). Urnes, Weltzien, Zanussi, Engbakk, and Kleppen-Rafu (2002) reported some success using “structured play” that incorporated a “doll’s house” domestic setting furnished and populated with figurines. They asked participants to play out a “day in the life.”

Despite the range of techniques available to engage users of digital assistive technology in the design process, there may be many barriers to achieving this end when the user has autism. For example, fear of failure and motivational deficits may make it difficult to engage people with autism in the design process. Limited imaginative capacity and communication skills (Attwood, 1998) and low-level cognitive skills (Griswold, Barnhill, Myles, Hagiwara, & Simpson, 2002) may render the design interaction difficult for the designer, while misinterpretation by the untrained designer of laughter or giggling that may mask anxiety or stress may impair the interaction (Attwood, 1998). Additionally, many design processes involve a degree of learning (e.g., prototyping). This can be disconcerting and even distressing for people with autism if at the end of the design “experiment” the prototype is withdrawn and the newly acquired skills no longer have an outlet.

Given the great potential for misunderstandings, the difficulties of dispelling misconceptions, and the vulnerability of the target group, great care must be taken when planning to include people with autism in the design process. There is a need to ensure that designers have an understanding of which techniques, and what processes for the use of those techniques, might offer the best chance of successful user involvement in the design process. The purpose of the current study was to investigate the appropriateness of some of these techniques to obtain end-user input into the design of digital assistive technologies when the end user is autistic.

To assess the suitability of these techniques for engaging people with autism in the design process directly, it would have been necessary to submit users with autism to a series of design exercises with no practical outcome for them. However, because this population has characteristics such as dislike of change and tendency toward anxiety and stress when encountering new situations, working directly with them as users
was ruled out on ethical grounds. A second option was to use parents and caregivers as advisors or proxies for their children. However, we considered that this group, while highly motivated, would find the process potentially stressful. We also considered that their experience would be limited to their own child and, given the wide range of abilities and traits represented by the target group, their opinions would limit the ability to generalize any findings. Thus, we proposed working with professionals, specifically psychologists who have experience working with people with autism. This group has rich experience of the day-to-day activities of the users, a detailed knowledge of the underlying condition, and an understanding of the research process. We reasoned that they would thus be able to provide information on the appropriateness of particular techniques to engage autistic people in the design process and what modifications might be necessary.

Our next consideration was how to engage the psychologists in a productive way. Given that the study would mainly involve soliciting opinions, a group approach was selected as we concluded that agreement among qualified informants would make the findings more reliable. After considering the group research methods available, we selected the Delphi method, described by Delbecq, Van den Ven, and Gustafson (1975) as “a method for the systematic solicitation and collation of judgments on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of opinion derived from earlier responses” (p. 10). A panel of experts is enlisted to respond to a series of questionnaires. Each successive questionnaire is developed from the panelists’ responses to the previous questionnaires. Delphi studies were originally conducted by mail, but questionnaires may also be distributed by email or, as in the case of the current study, by an online survey tool.

The Delphi method is especially useful in situations, such as the current study, in which the direct collection of empirical data is impractical (Angus, Hodge, McNally, & Sutton, 2003; Møldrup & Morgall, 2001; Nevo, Benbasat, & Wand, 2003). Lang (as cited in Møldrup & Morgall, 2001) stated that the Delphi method builds on findings that a group of individuals are more likely to make accurate predictions than if the same individuals were working alone and that face-to-face group meetings are prone to bias through the impact of influential members. Delphi also has an advantage over focus groups and other group techniques in that it allows panelists time to consider and be creative in their responses, which may be stifled in an unstructured group environment (Cho & Turoff, 2003). In addition, as each panelist is provided with a complete set of questions to respond to, more equal contributions can be expected.

**METHOD**

**Participants**

The recommended number of panelists when using the Delphi method varies considerably. Delbecq et al. (1975) suggested that, for a homogeneous group, 10–15 panelists is appropriate. Linstone and Turoff (1977) suggested 4–7 panelists as a minimum, while Dalkey and Helmer (1963), in their seminal study of the effects of nuclear conflict, used a panel of 7 members. Large panels are not recommended as they tend to generate a burden of data to be analyzed with little additional insights (Delbecq et al., 1975).

Seven experts on autism participated in this study. They were selected by reputation and referral, including snowballing. The experts were all psychologists, identified by their active work with the target group. One panelist worked mainly with autism and another mainly with Asperger’s syndrome, while the remaining five panelists had a mix of clients with both autism and Asperger’s syndrome. The panel was well qualified and could be regarded as expert. All of the panelists reported no involvement with the design of technologies. Table 1 shows the qualifications of the panelists and their experience in working with people with autism spectrum disorders.

**Materials**

Four scenarios were developed, each one describing the use of a technique that might be employed by a technology designer at the requirements stage of a user-centered design project. While user involvement is desirable at all stages of the development process, the requirements stage was selected for study as it is the stage where input by the user can have the greatest influence on the direction of the development. The choice of techniques was based on offering different levels of interaction between the user and the designer. The techniques selected also required a variety of different skills of the user. The techniques selected for
the studies were video, self-photography, thinking aloud, and role play (doll’s house). While these techniques had not been employed in the design of technologies for people with autism spectrum disorders, their use with this group was not without precedent:

- Video recording and review has been used in teaching social skills to people with Asperger’s syndrome (Attwood, 1998, p. 44).
- Self-photography: When users with a cognitive disability were given mobile devices incorporating mobile phone, a digital camera, GPS, and software for planning and communication support, the most used feature was the camera (Danielsson & Svensk, 2001). Danielsson and Svensk described empowerment as a common benefit.
- While all young children will go through a phase when they vocalize their thoughts, this period can be considerably extended among children with Asperger’s syndrome. This thinking aloud behavior can become a social problem, and some children need to be taught to suppress their “thinking aloud” (Attwood, 1998, p. 82).
- Role play may be used as part of social skills development among people with Asperger’s syndrome (Attwood, 1998, p. 114).

A common background of the context was provided for the scenarios:

You will be asked to consider some scenarios. They will all include two characters, John and Dianne. John has autism. He is 18 years old, and has just started a job as a trainee cook. Dianne is a technology designer. Dianne has been engaged to design a technology to assist John at work, in leisure activities, at home, and as he travels. It is important that John be directly involved in the design process from the outset so that the final design is a genuine reflection of his wants and needs. The scenarios will describe techniques that Dianne may use to work with John to identify those wants and needs.

The user, John, was described simply by age, occupation, and diagnosis. Little detail was given of his abilities to encourage panelists to respond in a qualified

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<thead>
<tr>
<th>Panel member</th>
<th>Qualifications</th>
<th>Relevant experience</th>
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<tbody>
<tr>
<td>Panelist 1</td>
<td>BA (Psychology and Sociology), GradDip (Psychology)</td>
<td>Neurodevelopmental coach working with Asperger’s syndrome and high functioning autism, including working on difficulties with organization, time management, planning, prioritizing, etc.</td>
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<tr>
<td>Panelist 2</td>
<td>Bachelor of Speech and Language Therapy; BA (Psychology) Master of Applied Linguistics; PhD Linguistics (in progress)</td>
<td>Counseling individuals with autism/Asperger’s syndrome and families living with a child/adolescent/young adult with autism/Asperger’s; developing programs with professionals (e.g., teachers, OTs, speech pathologists) to work on skills for individuals with autism/Asperger’s syndrome</td>
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<tr>
<td>Panelist 3</td>
<td>Psychologist (Sociology &amp; Psychology of Disability)</td>
<td>Private psychology practice specializing in neurodevelopmental disorders including ADHD, Asperger’s syndrome, high functioning autism, autism, fragile X syndrome</td>
</tr>
<tr>
<td>Panelist 4</td>
<td>Master of Psychology</td>
<td>Psychological practice over many years including assessment, diagnosis, behavioral support, therapy, and counseling; program development for more than 2,000 clients</td>
</tr>
<tr>
<td>Panelist 5</td>
<td>BA, DipED, BEd, GradDip (Vocational Counseling), GradDip (Educational Counseling), MAPS</td>
<td>Twenty years working with Asperger’s syndrome; students across entire cognitive spectrum, including development of communication and management programs based on augmentative communication systems from signing to PECS</td>
</tr>
<tr>
<td>Panelist 6</td>
<td>BA, BEd (Counseling)</td>
<td>Private psychologist working with parents of or clients with Asperger’s syndrome; parent of 13-year-old daughter with Asperger’s syndrome</td>
</tr>
<tr>
<td>Panelist 7</td>
<td>BEd, BSpecEd, GradDip (Psychology)</td>
<td>Fifteen years working as school psychologist at the largest school for children with autism in Australia</td>
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way to the questions (e.g., “If John was sufficiently verbal, he could do. . . .”). In recognition that in the special settings for people with autism in Australia, a high proportion of the staff are women, the designer, Dianne, was cast as a female. This also allowed for the possibility of any comments by the panelists relating gender matching between the designer and the user. The four scenarios were as follows.

**Video Scenario**

Dianne spends 3 days getting to know John and having discussions with the people who work with him. Dianne develops a framework of John’s current activities and assistance. Through her discussions she has also tried to establish the motivators for John to be involved in the design process. Dianne and John work together at John’s work to perform tasks that give an opportunity to establish a working relationship and trust. The camera operator is introduced during some of these sessions and the purpose of the project established. Once some familiarity is achieved, Dianne and the camera operator accompany John through a typical day, starting as he prepares for work in the morning. They travel to work with him recording parts of the trip. At work Dianne follows John as he performs his work. The camera operator is not involved at John’s work. Later, Dianne spends some time reviewing the tape and her field notes, making notes on her perception of John’s information needs. She then reviews the tape and her notes with John, revisiting the sites as needed.

**Self-Photography Scenario**

John is given a Polaroid camera for 2 weeks. He is asked to document his daily life: home, work, travel, leisure activities. In particular, he is asked to take a picture when he is stuck, perhaps when he has forgotten a task or encounters something unexpected. Each night, he assembles the photos into an album. At the end of each week he goes over it with Dianne, either at home, work, or at Dianne’s office. John talks about the problems that he had during the period, using the photos as illustration and as a reminder. Dianne uses the discussion to suggest to John possible ways that technology could be used to help.

**Thinking Aloud Scenario**

For this scenario, we will assume that John has a support worker, named Ros. They are comfortable working together. John and Ros are fitted with lapel microphones, and a camera operator follows them at a discreet distance. In order for John to define the functions of a new assistive technology, he and Ros go through what might be a typical day for John, at work, about the house, etc. As they do they “think aloud” about what John is doing, and what information he may need or want. Later, Dianne reviews the recording and makes notes. Dianne then reviews the notes and recording with John and Ros, at Dianne’s office.

**Role Play Scenario**

Dianne has constructed “doll’s house” sets to emulate home and work. Between “home” and “work” is a roadmap with bus, train, shops, and so forth represented. It is not an exact representation of these places and is not to scale. John and Dianne talk through the activities of a typical day, starting off in the morning at home and ending in the evening. John discusses what he does as he moves through the “small world.” The session is videotaped for review by John and Dianne later.

**Procedure**

Following approval from the University of Melbourne Ethics Committee, an outline of the project and an invitation to participate were sent to 19 psychologists. Seven responded positively and were sent the log-in details for an online survey tool developed for the creation and deployment of the Delphi study.

Two key characteristics of this project were that panelists did not communicate directly with each other and that their identities were not known to each other. These are common, but not essential, characteristics of Delphi studies. Anonymity was important for this project because it was likely that the prospective panelists would know each other either personally or by reputation, and therefore it was possible that their responses would be influenced if that anonymity was not preserved. According to Addison (2003), likely outcomes of violating anonymity include panelists deferring to the opinions of a dominant panelist, panelists giving less than full responses or responses biased by the knowledge of their audience, and possible conflicts arising between panelists over professional or personal differences. This partitioning of the panelists represents a trade-off with the potential benefits of interaction offered by other group techniques (Graham, Regehr, & Wright, 2003).

As mentioned earlier, the Delphi method consists of two or more rounds of questions that are put to the panel. Cramer, Epstein, Sheps, Schechter, and Busser (2002) reported that for Delphi studies that focus on simple ranking of existing ideas, one round may be sufficient, while for most other studies two to three rounds are required. While consensus is improved with successive rounds, this is tempered by the onset of respondent fatigue, which Cramer et al. reported setting in as early as Round 2 or 3. The Delphi study for this project was planned to run for two to three iterations, depending on the level of consensus and the quantity of new ideas emerging from Round 2. The number...
of iterations may be reduced by introducing some framework into the first round, rather than simply soliciting ideas (Cramer et al., 2002). As this project presumed no knowledge of technology design techniques among the panel, it was appropriate to base the first round on the prepared scenarios. This resulted in better-focused first round responses, which in turn enabled us to start rating and ranking of ideas in Round 2. The data thus gained were analyzed, and a summary including dissenting comments was used as the basis for questions for the next Delphi round. This Delphi study ran for three rounds. Figure 1 shows the structure of the data collection process.

Round 1 consisted of three sections. The first section asked demographic questions to establish the expert status of the panelists. The second section commenced with the profile of a young adult user with autism and introduced a designer who would work with the young adult to develop an assistive digital technology. The four design scenarios were then described. Each scenario was followed by questions relating to the appropriateness of the location for the activity, the user’s perceptions of the process, any possible problems, and any suggestions for improvement. This section yielded a great deal of data, some of which related to specific activities and some of which was of a more general nature. The third section of Round 1 solicited any further comments from the panelists.

Round 2 consisted of two main sections. The first section included providing feedback to each panelist on his or her responses from Round 1 juxtaposed with the summaries of the common responses. Panelists were asked to state whether they felt each summary was accurate. Each summary was followed by a listing of minority responses. Panelists were asked to register how important they felt each response was. A 5-point Likert scale was used for this. An opportunity was also provided for panelists to add comments or qualifiers to each statement. Each list was followed by a refined scenario, altered to accommodate the common responses from the first round. Panelists were asked to critique these revised scenarios. The second section of Round 2 was an opportunity for the panelists, having considered the problems and issues surrounding the design process, to offer advice to the designer on working with people with a cognitive disorder. To ensure that the advice would be provided in a common form, a template was designed. Five copies of the template were provided to each panelist. This section

![FIGURE 1 Structure of the data collection and analysis process.](image-url)
concluded with another opportunity for the panelists to make statements on any aspect of the study.

Round 3 was designed solely as a voting round. The responses to both the specific and open questions submitted by individual panelists in Round 2 were circulated to all panelists for rating on a 5-point Likert scale of importance. The importance of the advice was measured by the frequency of ratings of “important” and “very important.”

Data were downloaded from the Web site at each stage of the Delphi. Following the six-step procedure outlined by Braun and Clarke (2006), two of the researchers (Francis and Firth), both of whom have extensive experience in qualitative analysis, conducted a thematic analysis of the data. The first step was designed to familiarize the researchers with the data. It involved reading and rereading the data and noting initial ideas. In the second step, initial codes were generated and applied to the entire data set. In the third step, codes were grouped into potential themes, and all data relevant to each potential theme were gathered. The themes were then reviewed against the coded extracts and named (Steps 4 and 5). Finally, the results were summarized (see below) to provide insights into the engagement of people with autism in the design process. This qualitative work was supplemented by quantitative data from requests for panelists to rate comments.

RESULTS

Derivation of Recommendations

All of the techniques used in the study (video, self-photography, think aloud, and role play) were heavily qualified by the panelists. This is a reflection in part of the diverse traits and abilities of the target group. Two panelists observed in the first round that “John,” the user in the scenarios, appeared to be only mildly disabled (quite a high-functioning individual). While it was intended that the person should have the potential for transition into independent living, thereby being a potential candidate for an assistive technology that enabled mobility, this criticism was noted and a new profile was provided for the second round. Two panelists commented that some opinions were difficult without more information about John’s specific condition.

Taking the results from all rounds, it was possible to develop recommendations for the use of each of the techniques—video, self-photography, thinking aloud, role play—as well as a set of general recommendations for the involvement of people with autism in the assistive device design process. The recommendations emerged in a number of ways throughout the Delphi process:

- Common occurrence in Round 1: Analysis of Round 1 identified some common responses from the panel. These were regarded as representing a majority view and were presented to the panel in Round 2 in the form of a summary. Panelists were then asked to affirm or qualify the summary. Those responses affirmed by the panel became recommendations. One such case emerged from the self-photography scenario: “John may not choose the appropriate locations, times, or subjects for his photos.” This view was expressed in varying ways by five of the seven panelists in Round 1. It was subsequently affirmed by the panel in Round 2 and is expressed in Recommendation 3 for self-photography.

- Minor occurrence in Round 1, highly rated in Round 2: Any minor occurrence of a comment was returned to the panel in Round 2 to determine if it would be supported more widely. If the panel did affirm the comment in Round 2, then it was considered a recommendation. For example, only two panelists commented in Round 1 that the designer may have difficulty working with the individual or interpreting his responses; however, when this was put to the panel in Round 2 as “Ensure that Dianne has a good understanding of the underlying conditions and knows John’s particular issues,” the panel unanimously rated it as very important, thereby qualifying it as a recommendation.

- Proposed as “structured advice” in Round 2 and affirmed by panel in Round 3: Given that the panel had been involved in the project for two rounds and could be assumed to have reflected upon the issues raised in Round 1, panelists were asked at the end of Round 2 to provide advice to technology designers. The seven panelists contributed a total of 14 such suggestions, which were returned to the panel for rating in Round 3. All 14 suggestions were affirmed by the panel and became recommendations. One such suggestion was “Because the client may have poor memory functions, the weekly review of photo album could cause too great a demand upon such. This could result in substantial loss of material.
Therefore, some augmentive memory aid should be incorporated to complement pictures—even a brief telephone call at the end of each day.” This substantially formed Recommendation 1 for self-photography.

- Proposed by the researchers after Round 1 and affirmed by the panel in Round 2: One example of this was the proposal to “give plenty of opportunities for practice,” which was not expressed by the panel in Round 1 but was considered by the researchers to have potential application. The panel unanimously affirmed this in Round 2 as either important or very important, so it was included as a general recommendation.

General recommendations for engaging people with autism in the design process and recommendations for each specific technique were developed. The latter are summarized in Table 2, while the former are described below.

**General Recommendations**

**Obtain Background Knowledge on the Client**

The designer must have a good understanding of the underlying conditions (autism, Asperger’s syndrome) and also must be familiar with the user’s particular traits and abilities. He or she should be sufficiently familiar with the user to know in advance if there is likely to be a problem. The results derived from formal testing that assesses intelligence or severity of autism might be helpful in some circumstances, but knowledge of other characteristics is also important. This applies to cognitive, psychological, and physical capacities, as detailed below.

**Cognitive Capacities**

If the client has a problem comprehending or expressing, this could result in misunderstanding between the designer and client, with a loss of potential information. Therefore, the most appropriate communication aids should be selected to enhance the requirement elicitation process (e.g., using visual cues such as pictures/photographs taken). Similarly, if the client views a particular detail that others consider to be irrelevant as important (or vice versa), this could result in the program being ineffective, as the individual will not see the need to change/learn a difficult skill. Therefore, the designer must review and understand the user’s interpretations/perceptions and get the user’s input.

**Psychological Issues**

Because the client may have rigid patterns of thinking and behavior, new techniques and the increased focus upon his or her actions and skills could cause immediate anxiety, stress, and a sense of being overwhelmed and could lead to maladaptive behaviors. This could result in the client being unwilling to participate. Therefore, the designer must be cognizant of the client’s psychological issues and skills and build in a safety word that has been regularly used (e.g., “escape,” “sanctuary”).

**Physical Issues**

Because the client may present with motor or physical problems (e.g., a coexisting disorder), he or she may be unable to physically manipulate, hold, or implement technological devices. This could result in lack of use, poor learning, low confidence, and decreased motivation. Therefore, a variety of “additional” options, such as different sizes and weights of devices, may need to be considered in the design to overcome such problems. Visual problems may also lead to poor use, lack of motivation, stress, and confusion and result in a lack of compliance and poor use of the device. Therefore, it is also vital to consider the visual abilities of the user/client.

**Consider the Environment**

The panel noted that a needs analysis should be conducted with the user in situ. The environment can, however, be distracting for the user, and it may be appropriate to minimize distractions by selecting quiet times. The impact of distractions can also be reduced by focusing the user on the task at hand. When selecting the location for briefing or review sessions, it may also be useful to do so at each location in which the user activity being discussed takes place. This can serve as a memory-jogger for some users. However, users may be overloaded by the simultaneous demands of reviewing the task they were performing at the time (such as selecting grocery items or checking a schedule at a railway station) and managing environmental events. It may also be appropriate to conduct the review in situ as the situations occur, rather than at a return visit.
<table>
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<tr>
<th>Technique</th>
<th>Overall evaluation</th>
<th>Specific comments</th>
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| Video           | Provides a rich record of the user’s activities, and the recording can be replayed and reviewed as needed.                                           | 1. While the presence of a video camera will influence the behavior of most people, the impact on people with autism is likely to be greater. Apart from the distraction caused, the user may experience high levels of stress and overload. These impacts could result in withdrawal. Possible adjustments to improve acceptance are to use a less obtrusive video technique or to desensitize the user through practice.  
2. Plan to provide breaks in the videoing. It is also particularly important to clearly communicate the process and the opportunities for breaks to the user to allay any fears.    
3. Without a sound understanding of the underlying conditions and familiarity with the users, the designer is likely to misinterpret what they see on a video.   
4. When reviewing video with the designer, the user may have difficulty with making projections (“what if” questions).   
5. When reviewing video, the user may be overwhelmed by all the action in the video.   
6. Allow users some experience of the process from the designer’s viewpoint, perhaps by letting them get “behind the camera.” This may provide greater familiarity and reduce anxiety. In some cases, however, the increased access may result in increased anxiety or an unwillingness to return to being the “subject.” |
| Self-photography| The nature of photographs makes them an appropriate medium. They are discrete, which may be preferable to video, which is continuous. They lend themselves to manipulation and labeling by the user, giving ownership and familiarity. | 1. The individual may have poor memory functions. Too infrequent reviews of the photo album with the designer could cause too great a demand. This could result in substantial loss of material. Therefore, some augmentative memory aid incorporated to complement pictures is needed, even a brief telephone call at the end of each day.  
Alternatively, the designer should conduct more frequent review sessions.  
2. Care must be taken by the designer to ensure that the user has the abilities needed to safely undertake this activity. The client may be unable to detach from subjectivity to objectivity. The self-record using camera could cause even greater anxiety. This could result in dysfunction with no recording completed or, even worse, compromise the subject’s defensive responses in hazardous situations, leading to injury. Therefore, no system that divides the subject’s resources at times of stress should be considered. It may mean restrictions on the locations and activities recorded.   
3. Users may not choose appropriate locations, situations, or subjects for their photographs. |
| Thinking aloud  | Offers the opportunity to yield interesting information. However, it requires a high ability on the part of the user, and for some the equipment used (microphone) may be a barrier. May be better suited to users with Asperger’s syndrome. | 1. Developer needs to understand clients’ unique skill set and use their obsessions or interests to assess skills. The client may not have well-developed self-talk. Requiring individuals to speak aloud about their process of thoughts/feelings could cause distress or parrot responses. This could result in frustration and lead to aggressive behavior or self-protection to get out of program, leading to program failure.    
2. The role of a familiar person to support the vocalization of the user is essential to this technique. |

(Continued)
**Engage the Client**

The user must fully understand the purpose of the activity. If the client does not understand the need to change, or want to change his or her behavior (i.e., the client lacks insight), the activity could cause apathy and disengagement from the design process. However, limited insight into the activity and its purpose could also cause confusion, resulting in an eagerness to participate or please. Therefore, establishing that the client has a clear knowledge of what is happening or is supposed to happen is crucial. A full explanation needs to be given to the client as to what the client is specifically doing.

**Consider Communication**

The client may be easily confused by too many instructions. This could result in nothing positive being achieved. Therefore, taking things slowly and making sure there is no overload of information is important. Clear, step-by-step communication is essential, and instructions should be written up in simple words and be specific (i.e., with no margin for interpretation). Colloquialisms, jargon, slang, and ambiguous words should be avoided, as these could cause unexpected distress and confusion of expectations and could result in avoidant, aggressive (self-protective), or distressed behaviors.

Appropriate visual tools could be used to aid the user’s understanding of the process. This could include any tools that the client is already familiar and skilled with; pictures or videos of the process could also be used. Information about outcomes can be difficult for individuals with autism to process, and the designer should use a carefully structured explanation with checks that the client indeed understands what the designer is communicating.

**Respect the Client’s Self-Image**

Preservation of self-image and control are important to people with autism. Steps should be taken to ensure that the user is comfortable with performing the activity, especially if it is to be performed in a public place. Activities should not be explained to the client in terms of success or failure. The client’s criteria for success and failure will be different than the designer’s. The client may take perceived failure much harder than others, so the designer needs to ensure that situations where failure might be perceived are anticipated and avoided. If there is doubt about the client’s ability to manage the activities, the complexity of each activity should be gradually built up to allow the client to become accustomed to it. The client should be given plenty of opportunities to practice new skills.

**SUMMARY**

The importance of involving users of all assistive technologies in design processes cannot be overstated, although to date digital assistive technology development projects have not done this well. The findings of this study suggest that there are significant, but not insurmountable, issues for designers working with people with autism. Although none of the techniques used in the scenarios in this study were clearly better than the others, the recommendations derived relating to each technique and the general recommendations provide some guidance to those who may need to engage people with autism in the design stage of developing assistive technologies. The recommendations are important in that designers come from backgrounds that typically do not engage with such populations and may not be aware of their characteristics and special needs and the many challenges they pose.

The expert panelists were asked to give responses based on their current knowledge of technology and of the particular cognitive and communication conditions being considered. Further, their gauging of the reactions and perceptions of the target group was based on their perceptions of the target group’s current understanding of, and exposure to, assistive digital technologies.

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TABLE 2 (Continued)

<table>
<thead>
<tr>
<th>Technique</th>
<th>Overall evaluation</th>
<th>Specific comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role play</td>
<td>Offers good opportunities for information gathering with two qualifications: the user is able to role play, and the user finds it relevant.</td>
<td>1. Make sure that the set and props are realistic.</td>
</tr>
</tbody>
</table>

**TABLE 2**

(Continued)
The final balance of user-designer input into the design process was not covered in this research, which was predominantly aimed at furthering the ability of designers to involve users with a cognitive disorder in the design process. There is scope for continued work in design methodologies for people with autism.

CONCLUSION

We investigated issues surrounding the direct involvement of people with autism in the design of digital assistive technology. We found that there was no clear “winner” among the techniques examined, as all would need some modification and management. This is consistent with Iovannone, Dunlap, Huber, and Kincaid (2003), who, in considering appropriate educational practices for students with autism, asserted that as people with autism are heterogeneous in nature, no single technique would be likely to suit all cases. The aim, instead, should be to match the appropriate technique to the individual.

Despite this, we have identified some general rules that should be followed when people with autism are involved directly in the design process. In particular, care must be taken to conduct a thorough assessment of the user and his or her abilities, motivators, and behaviors prior to selecting a suitable technique. Developing a solid and trusting working relationship is paramount when working with this user group. The designer should be experienced in the disorder. This is especially relevant for people with autism as interpretation of the user’s emotions and level of understanding may be difficult.

This research suggests a number of avenues for future work. In particular, while one finding is the importance of the designer to understand the individual and his or her underlying condition, and it can be expected that there will continue to be a growing number of designers who choose to specialize in the design of digital assistive technologies, another approach to this problem of knowledge is to permit the users and those who support them greater access to the means to design their own digital assistive technologies. This “support network” possesses a rich set of skills and experience and already has an effective working relationship with the user. We are currently exploring this group and the potential to engage them more effectively in the design process.

REFERENCES


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