



# Design and Development for Individuals with ASD: Fostering Multidisciplinary Approaches Through Personas

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## Abstract

Developing technologies to support individuals with ASD is a growing field of research facing numerous challenges. First, while the individual with ASD is central, the motivations of others, such as parents, are often taken as the motivations of the individual. Second, the desirable cross-disciplinary pollination for improved intervention can often face difficulties due to a lack of a common language among disciplines. Thirdly, the literature often lacks enough information to allow a clear understanding of the targeted contexts and goals not enabling an assessment of outcomes and building on past advances. To tackle these challenges, we propose that families of Personas and scenarios are used throughout the design and development process, and as dissemination resources, and provide illustrative examples.

**Keywords** Autism · ASD · Technology · Multidisciplinary · Personas

## Introduction

The widespread availability, at an affordable price, of novel sensing and mobile technologies, such as tablets and smartphones, and their wide range of processing and interaction features, make them an interesting choice as the base for providing individuals with ASD with systems that support them (and those around) in their daily life (McCleery 2015; Shic and Goodwin 2015). This can be performed ubiquitously in a way that is more socially acceptable than in the past (McNaughton and Light 2013).

Individuals with ASD tend to favour technology for several reasons (Mazurek and Wenstrup 2013; Diener et al. 2015; Lofland et al. 2016), such as the repetitive, well behaved environment that they provide (Frauenberger 2015). As a result, the number of technologies proposed for people diagnosed with ASD (da Silva et al. 2012; Perez et al. 2015) has been growing rapidly in the past few years (Fletcher-Watson 2015; Shic and Goodwin 2015; Lorah et al. 2015),

with a positive use of technology reported for intervention (Odom et al. 2015; Fletcher-Watson 2014; Wong et al. 2015).

However, in many situations, technology development is driven by what is technologically possible rather than by specific needs (e.g., in communication) of the target users (Light and McNaughton 2013; Lofland et al. 2016). This can result in tools that are technically appealing, but neglect ease of use and adequacy to the individual's abilities and needs, turning technological contributions into a useless effort or even a burden for the targeted individuals, imposing a strong learning cost (Light and McNaughton 2013). Additionally, the role of those who interact with the main user of the technology should also be carefully considered (e.g., parents, teachers, clinicians, therapists).

## Design and Development Challenges

Developing technologies for users with ASD, entails several challenges. First of all, even considering co-design methods, devised to focus on user needs (e.g., participatory design (Frauenberger et al. 2011), and user-centred design (Lubas et al. 2014), there are several viewpoints at stake, from the targeted person to family and carers, needing careful consideration. While the common practice is to consider the motivations and needs of the target user as the most important, evidence shows that technologies need to

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be supported by the social network around the primary user. In a study by Pellicano et al. (2014), stakeholders argued in favour of “greater investment in research that assists with the day-to-day living with autism—for those who are autistic themselves, their family members and those who work with them”. Therefore, conflicting interests and motivations among those who will use or supervise the use of the proposed system need to be carefully tackled and articulated (Hendriks et al. 2015; McNaughton and Light 2013), also taking into consideration, for instance, how these are affected by the targeted socio-cultural context. Additionally, this emphasises the need for research covering practical issues of daily life.

A second challenge concerns multidisciplinary. Providing novel technologies to support intervention for autistic persons is an inherently multidisciplinary work (Porayska-Pomsta et al. 2012; Odom et al. 2015), gathering knowledge and views from different disciplines encompassing, among other fields of expertise, psychology, education, therapy, signal processing, human-computer interaction and software engineering (Cox 2012). This requires that different experts are able to communicate and discuss their ideas in a shared language (Parsons et al. 2015) fostering a better understanding of what is at stake. For example, researchers and developers often have a limited knowledge regarding the focused impairment and therefore have trouble deciding how to balance the different interests. The knowledge and views of different stakeholders need to be discussed and put to practice in a tight collaboration effort (McNaughton and Light 2013). As identified by McCleery (2015), the integration of the fast-evolving technologies into relevant proposals for the life of individuals with ASD requires meaningful multidisciplinary conversations that integrate the different perspectives.

Additionally, even if deficits appear as clearer targets for the technology to tackle (Frauenberger 2015), it is more important to focus on abilities and talents rather than on disabilities (Benton and Johnson 2014; Diener et al. 2016), exploring a wide scope view over what can be meaningful for autistic people and proposing solutions that blend with their world. Therefore, another important challenge concerns how to put these abilities and talents into evidence and how to provide the different team members with a deeper, more humane holistic view of the targeted users.

These three major challenges are encompassed by what Hendriks et al. (2015) identify as two of the aims of co-design: (1) equivalence, i.e., supporting equal contributions and collaboration through a shared language; and (2) balancing viewpoints, considering and articulating the different viewpoints of stakeholders over the targeted condition and improving the researcher/developer understanding of it.

Finally, although many technologies are being proposed to aid people diagnosed with ASD, there is little attention

paid to details on how these technologies are designed and developed, and how they build on past advances (Lubas et al. 2014; Fletcher-Watson 2014; Benton et al. 2015; Hendriks et al. 2015; Fletcher-Watson 2015). This might result from a general tendency to pursue technological novelty rather than user needs, but also from the absence of a consistent methodology to design, create and evaluate new technologies (Fletcher-Watson 2014). In this regard, the detailed publication of the methods used for design and development along with a detailed depiction of considered users and contexts can support a structured approach to future advances (Lubas et al. 2014; Benton and Johnson 2014; Hendriks et al. 2015). Publishing outside one’s discipline to engage in an easy exchange of experiences among subject areas can also be an important action (Fletcher-Watson 2015).

## Contributions and Overview

In light of the identified challenges, we propose that a set (a family) of Personas, i.e., fictional characters considered to describe the users (Cooper et al. 2007; Adlin and Pruitt 2010), created in a specific manner, along with scenarios, are considered in the context of developing technology for ASD contexts, enabling:

- Holistic view of the individual with ASD and his or her world, leveraging abilities and providing a more humane view of users and other stakeholders;
- Articulation and understanding of the different motivations and requirements for the user and other directly interested parties such as parents and teachers;
- Design for ecology (Hourcade 2017), depicting a context that is closer to reality;
- Shared, multifaceted vision of the targeted users and design options among members of a multidisciplinary team, providing an approach to tackle the challenges of equivalence and viewpoint balancing (Hendriks et al. 2015);
- The use of Personas and scenarios as an integral part of scientific reporting, to favour a better depiction of the targeted users and contexts, and to support comparative analysis among different works.

## Background and Related Work in Design and Development for ASD Contexts

This section surveys recent literature regarding development of technology for individuals diagnosed with ASD, with a particular emphasis on children, the most active line of work, to assess if, and to what extent, the identified challenges are being addressed.

The work of Brosnan et al. (2016) emphasizes the interdisciplinary nature of participatory design and how it needs to support active contributions including communities beyond academia, providing different perspectives and voices, in such a way that the resulting contributions can be traced and evidenced. As far as we could grasp, this evidence is far from being provided in the literature. Outcomes are well presented and validated, often with feedback from actual users and assessment of the impact of the proposed technologies. However, it is, often, difficult to grasp the context and audience. While the community might aim for a similar outcome, it is kept in the blind to many of the aspects collected and learned throughout the process, and which might be valuable to feed novel work.

In this line of thought, Hendriks et al. (2015) propose that method stories should be introduced as a tool for providing the community with the rationale behind each co-design approach, providing information regarding, for instance, the equivalence among participants, balancing of their viewpoints, and how co-design techniques were adjusted to serve the particular context.

In Boyle Arnedillo-Sánchez (2016), the authors explore what contributions can be provided by adults when designing for children with ASD, as communication proxies and as experts in dealing with ASD in a day-to-day basis, and reach the conclusion that it is still challenging to exactly identify what kind of contributions parents and professionals can make and how to facilitate their articulation of these contributions. This is also one of the conclusions of Benton and Johnson (2014), on their review, analysing the role of stakeholders as co-designers.

A few works explicitly address the inclusion of additional contributions by relevant stakeholders. Parsons et al. (2015) describe digital stories as a method to foster knowledge exchange and co-creation among teachers and researchers. The authors report that these stories were important to foster dialogue and to explicitly capture practices and enable their discussion. This was, however, very labour intensive as the research team was left with the task of building the digital stories based on raw footage and ideas of the professionals. Mora Guiard et al. (2014) report the use of narrative resources as mediators among different disciplines and generations, facilitating the articulation of the different voices into a coherent story.

Malinverni et al. (2016), while discussing a method to evaluate and communicate participatory design, propose multimodal analysis to cover the collection of multiple aspects of users' contributions by going beyond intentional communicational prompts (e.g., movement, gaze). The authors argue that this, by providing empirical data to analyze side-by-side with the design questions, can also serve as a starting point to foster the discussion among multiple stakeholders, facilitating multidisciplinary communication

and the orchestration of multiple perspectives. The subject of integrating contributions from a diverse set of stakeholders is also tackled in (Malinverni et al. 2017) considering an inclusive design model, for the proposal of a video game, encompassing narrative resources and game design praxis.

Overall, while these methods are already important instruments to elicit, discuss and articulate contributions by different stakeholders, through a shared language, they lack two important aspects. First, these methods consider the stakeholders, but design teams often include members, such as designers and software developers, who need a grasp over the complete context. Second, explicitly specifying the different stakeholders and their main motivations fosters a greater awareness, among the team members, regarding who is involved (and why) in setting the requirements for the application.

Furthermore, the literature profusely discusses co-design, but not much is directly discussed regarding co-usage, i.e., the consideration of stakeholders as actual users of the technology, along with the target individual. In many scenarios, applications are intended for co-usage, but without explicitly considering the motivations for the different co-users. Those motivations sometimes end up being described as the motivations of the individual with ASD resulting in a lack of clarity as to what are the real contributions and needs of the stakeholders. Personas can help, in this regard, explicitly bringing balanced co-usage into play.

## Personas

Personas (Cooper et al. 2007) are fictitious representations of target users and their goal is to provide information about the users in a more humane, engaging and memorable way (Adlin and Pruitt 2010) than, for instance, a list of characteristics, to be considered during design and development. Personas are used in a wide variety of contexts and application areas and have been shown to add to the design and development process in a number of aspects (Miaskiewicz and Kozar 2011) such as: improved focus on the audience's goals, rather than on the technological possibilities; support to design decisions, by providing a clear picture of user needs and context; improved communication across teams and articulation of stakeholder's views; and their adequateness to be understood by both specialists and non-specialists (Barré et al. 2017). Christophe (2014) showed that while the use of Personas does not lead to an increase in the number of ideas produced, these ideas are frequently relevant and, on a slightly different note, So and Joo (2017) show that Personas increased creativity during brainstorming sessions by having a priming effect towards the target users and context.

Attempting to test a novel look into Personas, Bonnardel et al. (2016) propose dynamic Personas. The authors stress

the importance of Personas to support collaboration among designers and report that dynamic Personas, represented through an avatar in a virtual world, can elicit better design ideas. However, it is yet to be shown how a systematic implementation of these Personas can be accomplished as it currently depends on a researcher to play the role.

Matthews et al. (2011) introduced collaboration Personas focusing on groups of users rather than on individuals. These Personas account for multiple inter-related users, playing different roles in the same context, and for collective and individual goals that affect the collective goal. The authors have gathered some evidence (Judge et al. 2012) that collaboration Personas led to a more focused and complete discussion of the problems at hand than individual Personas and that they work as important communication tools among team members not directly connected with design and development (Matthews et al. 2012).

### Personas for Children with ASD

Personas have already been considered in design and development of technology for children, also known as child Personas (da Costa et al. 2016). Nevertheless, in the context of design and development for children diagnosed with ASD, only a few works have considered Personas, to different extents. A very simple and restricted approach to Personas has been considered to support the collaboration of children with autism in co-design (Millen et al. 2011) aiming to lessen the imagination effort of the children to focus their contributions. Frauenberger et al. (2012) refer the use of four Personas, to represent different children with ASD, and scenarios as part of their methods, to enable idea elicitation, testing, and presentation. The authors then created a video, at the end of the process, based on the storyboards, Personas and scenarios, depicting the rationale for decision making. As the authors highlight, making the design process transparent is beneficial for all team members and impacts on the amount of contributions they can provide. Culén and Karpova (2015) also briefly describe the use of Personas to support collaboration. Finally, McCrickard et al. (2015) consider Personas for two children diagnosed with ASD and scenarios as tools to contextualize different anger management techniques towards the development of support technology. The Personas, however, only include children with ASD (and no additional stakeholders), lack motivations and do not play a central role in the design process.

## Methods

Considering the challenges at hand, the design, development and dissemination of work regarding technologies for individuals with ASD might profit from the consideration

of a family of Personas – and not only that of the primary user—encompassing both the individual and any relevant stakeholders. The Personas, since they are descriptions of the users' characteristics and motivations in narrative form, can work as a canvas over which discussion among multidisciplinary team members might occur, enabling contributions and critique from different areas of expertise. Additionally, the Personas work as landmarks for the remaining stages of design and development and, together with scenarios will enable the definition of requirements for the envisaged system.

The remainder of this section provides an overview of the main steps considered to create, discuss and validate a family of Personas for a child with ASD. Although the overall method is generic and can be applied for the creation of any family of Personas, we consider, for the sake of simplicity, the overall context of Marie Curie's IAPP project IRIS, in which the authors were involved, aiming at proposing a natural interaction communication platform accessible and adapted for all users considering a domestic/school scenario.

### Creation of the Personas

A clear depiction of the context requires that a primary Persona is defined, i.e., the one at the centre of the design and development effort (in our case, the child diagnosed with ASD), and a set of secondary Personas, selected from those who interact with the child and are related with the considered context.

To decide which additional Personas should be included we considered two common scenarios: the household and school, as both parents and professionals have relevant roles in the life of a child with ASD (Boyle and Arnedillo-Sánchez 2016). Our Primary Persona would interact with her family, at home—mother, father, and a sister, and his teachers—regular and special education—and speech therapist, at school.

The process of researching and building the Persona was lead by a Speech Therapist with previous experience working with children with ASD, but no experience with Personas. This served two purposes: (1) ensure a strong input and coordination by someone with direct experience working with the target users and stakeholders; and, (2) show that someone without a background on these tools is able to understand the concept and apply it.

The choice and creation of the first draft for the different Personas was based on several sources of information and contributions: (a) the experience of the Speech Therapist leading the work; (b) a literature review focusing general information regarding ASD; (c) literature with a specific emphasis on the Portuguese context for kids diagnosed with ASD, focusing a characterization of ASD population and the role of professionals, such as Speech Therapists, in ASD contexts (Araújo 2009; Batista 2011; Pedro 2011; Santos

2009); and (d) brainstorming sessions with professionals (Special and Regular Education teachers), working in ASD contexts and application designers and developers.

### Validation and Contributions by Experts

In order to assess the relevance and clarity of the statements included in the first version of the Personas, as well as the need to include or remove some data, the Personas were then presented to a panel of field experts. To select the elements for the panel of experts we opted for a non-probability accidental sampling method (Battaglia 2008) selecting three Special Education teachers and two Speech Therapists working at Special Education schools for children diagnosed with ASD (Lynn 1986). The average age was 37 years and the average practice time was around 12 years. At this stage, these professionals were considered the most suited to provide a first validation and additional contributions to the first version of the Personas due to their close relationship with these children.

A questionnaire was delivered to the panel of field experts composed of seven sections, one for each of the proposed Personas, to assess the plausibility, relevance and representativeness of the included information. Most of the questions focused the different statements contained in the Persona of Nuno, since we wanted a more detailed insight for the primary Persona, and the experts were asked to evaluate them using a three level Likert-like scale (agree, neither agree or disagree, and disagree). If the answer was disagree, the expert was asked to provide the motives and a suggestion to improve that particular aspect of the Persona.

Additionally, each expert was asked to make an overall evaluation of the individual Personas using a five level Likert-like scale (bad, reasonable, good, very good, excellent). Experts could also freely provide suggestions (e.g., add or remove content) to improve any of the proposed Personas.

### Scenarios

Personas are the users of the system to be proposed, but they do not define how it will appear in their lives and how they will interact with it. For a particular approach being proposed, one can have multiple context scenarios that depict the different situations in which it can be used and involving one or more of the Personas. It shows where and when the user can take advantage of the system, to what purposes, with whom, for how long and what is the impact of using it in that particular context (Queiros et al. 2014). While Personas foster a shared understanding and discussion of the users and their motivations, scenarios enable a deeper insight over how the motivations of the Personas will be fulfilled through the envisaged technology (Steen et al. 2014). Additionally, scenarios are also important to assess how what is being

proposed integrates with current practises (Huijnen et al. 2017) and daily routines, and if there is a fit between what is proposed and the needs and capacities of the envisaged context (Dingfelder and Mandell 2011).

One relevant aspect for scenarios is that they should be created without thinking about what are the limits of the technology, but, primarily, about what features make sense to support the users in attaining their goals. Naturally, later on, this will need to be assessed, but thinking the scenarios this freely leaves more room for creative, out-of-the-box, user-centred solutions.

### A Family of Personas for a Child with ASD

This section presents a concrete example of a family of Personas proposed for a child with ASD created following the methods described above, including: (a) a child, diagnosed with ASD; (b) his family members—mother, father and sister; and (c) a group of professionals, related with school context—Regular Education teacher, Special Education teacher and a Speech Therapist.

#### Child

The Persona for Nuno Rocha, a 10 year old kid diagnosed with ASD, is presented in Table 1 and can serve as an example for explaining the overall rationale adopted for Persona presentation. The description of the Persona contains different parts corresponding to different subjects, as identified on the rightmost column. It starts by a general context for the child, school, curricula and technology adherence and then moves into language competences and social and behavioural aspects. In the Persona's narrative description, the motivation is the only part that directly derives from the context, i.e., might change, for the same Persona, depending on the application scenario. Accordingly, the Persona should be rich enough to cover all matters concerning the motivation. For instance, if Nuno's motivation concerned dealing with anxiety, the Persona should include a characterization regarding it. The motivation has a central role in the whole method and should not be defined lightly, as it will provide a measure of relevance for every option and scenario that is proposed afterwards and for an overall assessment of the work carried out: "Does this approach help Nuno to fulfill his motivations?"

#### Direct Family Members

The remaining Personas follow the same rationale described for Nuno's Persona. Table 2 presents the Persona for Laura Rocha, Nuno's mother. One of the notable aspects of this Persona is her definition as the primary carer of Nuno.



**Table 1** Persona for Nuno Rocha, a kid diagnosed with ASD

General characterization of the child



**Nuno Rocha**, born on February 20th, 2008, in Aveiro, Portugal, lives with his parents and a 13 year old sister. At the age of two he went to a Child Development appointment, at the district hospital, because his parents suspected that something was wrong, after which he was sent to an autism exam at the Paediatric Hospital of Coimbra. At the age of three, he was diagnosed with an Autism Spectrum Disorder (level 2 in the scale of severity), with associated cognitive deficits.

He is attending the 4th grade at Anadia's Primary School, benefiting from a Structured Teaching Unit (STU) delivering him a structured learning model (TEACCH) and the application of interdisciplinary intervention methodologies. He also benefits from Speech Therapy sessions. Nuno follows an individual curriculum (consisting of changes to the normal curriculum, by introducing, replacing or eliminating goals and contents). On a daily basis, for 2 hours, he attends the regular class to work sociability, whereas functional classes (like functional Portuguese, world knowledge, functional math and every day activities) are learned at the STU.

School and curricula

At home, he prefers to watch TV and play computer games. When asked about professional preferences, he mentions he would like to stay at home with his mother and watch TV or play computer games.

Technology adherence and proficiency

He appears to dominate the basic functions of a computer, but only uses his ability to play computer games. He is not able to research information on any search engine, nor does he use social networks for communication.

Receptive-expressive language

He appears to understand simple oral material, specifically words or sentences related with his social and familiar day-to-day. On the other hand, difficulties are observed on the comprehension of longer sentences that lack visual support or that are out of the context.

Added as a result of evaluation

The elected mean of communication is speech. *[He is mostly capable of using short and simple sentences (subject + verb + object). Regarding reading, he recognizes all the letters, but seems to struggle on the reading process, mostly syllabic, associated to a loss of purpose and hesitations.]* He writes with orthographic correction but he needs support on the structuring of small texts and in answering questions. He also presents difficulties using markers and morphosyntactic constituents by omitting link words, such as prepositions, along with difficulties in number/gender agreement for definite articles. He also has trouble in matching the verbal form with the personal pronoun (e.g., "I does"). He makes requests in his areas of interest, and when questioned he has difficulties in answering, sharing daily experiences, and beginning and keeping a conversation. He shows difficulties in keeping eye contact, respecting interaction shifts and adjusting to the context and to the interlocutor. In some situations, he verbalizes incoherent phrases and out of context (delayed echolalia).

Social interaction

At school, when he does not recognize his surroundings, he walks aimlessly, not asking for help. *[He gets anxious every time his routine is changed or when he's thwarted, presenting inappropriate and sometimes aggressive behaviours, as yelling, pinching, and biting whoever is around].* He shows attention/concentration deficit, namely failing to pay attention in the classroom, leading him to easily demotivate if the activity is not of his interest.

Adaptive behaviour

Regarding the daily routine activities (such as dressing and personal hygiene), usually he is able to conclude them with autonomy, requiring, from time to time, supervision to accomplish their sequence.

Daily routines

**Motivation:** Nuno would like to be more autonomous using social networks to communicate. Plus, he would like to be able to share with his parents the activities he performs at school, during the day.

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**Table 2** Persona of Laura Rocha, mother of a child diagnosed with ASD

## General information



**Laura Rocha** was born the 23rd of November, 1973 in Moita, Anadia county, Aveiro district. She is married to Miguel Rocha and has two children, a girl aged 13, Sofia Rocha, and a boy aged 10, Nuno Rocha, the latter diagnosed with ASD.

Laura has an MSc and works as an architect. Recently, she started working from home so she can provide additional support to her son and spend more time with him after school.

When her son was diagnosed with ASD she admits having lived a period of anguish, fear, and disappointment for not having a son as she had dreamt. Nevertheless, after the initial shock, she faced her son's condition and limitations with realism and positive thinking.

Due to her husband spending most of the time travelling, due to his work, she frequently plays the role of the primary carer, taking responsibility for all matters related with Nuno's care.

She is very interested and committed regarding all matters concerning her children's school. She often asks about her son's day and asks him to talk about his daily activities.

As hobbies, she likes reading, playing the piano, and travelling. However, since Nuno's birth, she seldom travels, since it is quite disturbing for him resulting in anxiety and aggressive behaviour.

She does psychotherapy every two weeks since her son was five years old and she reports that it helps her dealing with anxiety and stress associated with the demanding task of taking care of a child with ASD.

Her main concerns are strongly related with her son's uncertain future, if he will be able attend the university, have a professional activity or, simply, if he will be able to live an autonomous life.

**Motivation:** Laura would like to improve the communication between her and Nuno's school. She sees herself as a very interested mother, and likes to know about Nuno's activities and tasks during the day and his performance in them. Sometimes, she feels the need to share, but also to receive, information from Nuno's school regarding, for example, his homework. However, she does not have access to the means that might enable this interchange to be performed on a regular basis.

Education and job

Reaction to Nuno's diagnosis

Primary carer

Attitude towards school

Hobbies and free time

Dealing with ASD

Main concerns

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Laura's motivation—and the same is true for all Personas—is what connects her to the overall application context and needs to be taken into consideration when defining the usage scenarios.

Miguel Rocha, Nuno's father, is presented in Table 3. One distinguishing aspect in Miguel's description is how he deals with his son's condition and what are his main concerns towards him. This highlights that, sometimes, one of the parents (here, the father) has more difficulty in accepting the child's condition.

The sister, Beatriz Costa, is described in Table 4. Notice, for instance, the description of how Beatriz takes a role in protecting and helping her brother, and how she would like to have a more active role in taking care of Nuno and how

she reacted to his condition. While it might be argued, at a first glance, that this kind of details is not particularly relevant for designing and developing an application—and the same comment might arise for the other Personas –, they provide an insight on the humane dimension of the stakeholders and serve as context for their motivations.

## School Context

Beyond the family members, other stakeholders assume important roles in the life of a child with ASD and, considering the proposed context, we worked on three additional Personas related with the school context. All the narrative

**Table 3** Persona of Miguel Rocha, father of a child diagnosed with ASD

## General information



**Miguel Rocha** was born in Porto, Portugal, on the 2nd of December, 1971, and currently lives in Mouta, Anadia county, district of Aveiro. He is married to Laura Rocha and has two children, a girl aged 13, named Sofia, and a boy aged 10, named Nuno, diagnosed with ASD.

He has a BSc and he works as an external market manager in a multinational company. His work demands that he is constantly doing business travels. Education and job

During weekends, one of his favourite activities is to ride a bicycle with his daughter Sofia and he enjoys watching a good football match. However, he can rarely do it at home, since the associated noise triggers his son's agitated reactions including, for example, constantly turning off the television. Hobbies and free time

He never truly accepted his son's health condition. He initially believed it was just a temporary condition that would disappear after enrolling in school. He avoids situations such as going to the movies, a shopping day with the family or lunches and dinners out, due to the fear that Nuno may have behaviors that may seem awkward to others. Sometimes he does not even want close friends and family members to know about his son's strange behaviors. Dealing with his son's condition

Even though his relationship with Nuno is considerably less close than his wife's, one of his main concerns is also Nuno's well being when they cease to be able to take care of him. Main concerns

**Motivation:** Miguel would like to be closer to his son and share activities with him just like he does with his daughter.

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descriptions provide, on the rightmost column, a reference to the aspect being covered on the text.

Table 5 presents the Persona of Isabel Oliveira, a Special Education teacher. Notable aspects of her Persona are the receptiveness to novel knowledge and practices and her view on the potential helpful role that technologies can play to improve the life of children with ASD.

The narrative description for the Speech Therapist is presented in Table 6. Sara has experience working with children with ASD and introduces, in the overall context set by the Family of Personas, the consideration of music as a tool used during therapy.

Finally, Table 7 depicts the information for Sofia Rodrigues, Nuno's Regular Education teacher. One important aspect that surfaced during the creation of the Persona and particularly from feedback obtained from the professionals, was a reference to a set of difficulties that Regular Education teachers face when dealing with children with

ASD and how the integration of these children might bring challenges to these professionals.

Overall, notice that even though some of the motivations are concerned with the explicit purpose of improving communication with Nuno, the definition of the different Personas highlights the fact that these are individual motivations and should all be addressed and weighted.

### Personas Evaluation and Improvement

Overall, none of the Personas was classified as bad with the experts assessing them as good or very good 69% of the time. Regarding the detailed analysis of each of the child's Persona contents, the panel mostly agreed or was neutral towards the included information. In one or two cases, in which the expert disagreed with the content, it was mostly because it was considered incomplete, rather than wrong. As a result of the input provided by the panel of experts, some



**Table 4** Persona for Beatriz, sister of a child diagnosed with ASD

## Education



Beatriz Costa was born on the 30th of August, 2004 and lives with her parents and 10 years old brother in Moita, Anadia county, Aveiro district. Her brother was diagnosed with ASD. Currently, she is in the 8th grade and is a very good student. She is proficient with computers using them mainly to access different social networks and to perform content searches.

Outside school she enjoys ballet and plays violin. At home, she likes watching television, reading and helping her mother with the domestic chores. Hobbies and free time

Despite her brother's condition, she is able to establish a good relation with him. When he shows a noisy or destructive behaviour she tries to calm him down, giving him time and showing him how to deal with the situation. At school, during breaks, when other kids mock or bully her brother she tries to protect him. Relation with brother

When she was little, sometimes she felt jealous of her brother because he demanded most of her parents' attention. However, she now understands that Nuno requires a lot of attention and help and deals well with this situation. Understanding of Nuno's condition

When questioned about her future and professional plans she mentions she would like to attend the university and graduate in special education so she can help children diagnosed with the same condition as her brother. Expectations for future life

**Motivation:** Beatriz would like to have a more active role in taking care of her brother, to alleviate her mother from some of the stress and work that taking care of a child with ASD involves.

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information was added to the Personas—child, mother and Regular Education teacher—and is depicted in italics on the Personas' descriptions.

As an illustration of how the Personas can work to foster dialogue and shared experience, the addition regarding the difficulties felt by the Regular Education teacher when considering applications that are only usable by the child with ASD, in the classroom, was suggested by a researcher during a discussion of the Personas, at a congress Vieira et al. 2017.

## From a Family of Personas to Applications

For a particular design context, several scenarios can be proposed involving one or more of the Personas. In what follows, as an illustrative example, we present one of the scenarios built for the Marie Curie IAPP project IRIS (ref. 610986) (Freitas et al. 2014) as part of multidisciplinary

discussions in line with what was performed to create and improve the Personas.

In this specific scenario, presented in Table 8, a story is described recreating Nuno's day-to-day routine at school and describing how he can improve his communication and learning capabilities by using a special application previously installed in a tablet, a device selected for its portability and range of opportunities it brings in this context (Lorah et al. 2015; Xin and Leonard 2015; Allen et al. 2016). The scenario also provides a description of the surrounding environment that needs to be explored, the information requirements that need to be incorporated in the application, and the functional and interaction requirements. Note that the Personas of the mother and the Special Education teacher are also included interacting with the application.

This scenario, beyond conveying how the proposed system can help Nuno in fulfilling his motivations, can (and should) raise new questions and generate discussion. For instance, when the scenario describes "[...] allowing Nuno

**Table 5** Persona for Isabel Oliveira, a special education teacher

## General information



**Isabel Oliveira** was born in France, on the 20th of April, 1972, and currently lives in Aveiro. She is married to Luís Oliveira and has two daughters and a son.

She has a BSc in Language, Literature and Cultures, with a major in Portuguese and French, a post graduation in Special Education focusing on Cognitive and Motor development. Currently she is attending an MSc in Special Education. She has 19 years of teaching experience, 7 of those in Special Education at the Structured Teaching Unit for students with ASD of Anadia's primary school.

Academic background and competences

She has a very good level of knowledge regarding her field of work and she constantly works to be up to date with recent knowledge and practices. To provide the best to her students she always tries to improve her knowledge regarding every specific condition and adopt new pedagogic theories and didactic practices.

Constant update regarding novel approaches/interventions

From her point of view, information and communication technologies can be an asset during the learning process of kids with special educational needs and, during her work with them, she often uses computers and tablets with educational software.

Use of technologies to support intervention

Her main interests are literature, cinema, cooking, and writing, but, during her free time, her family is the main priority.

Hobbies

**Motivation:** Isabel would like to promote the autonomy and improve the learning process of Nuno, improving his motivation and participation in the school tasks.

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to associate an emotion to the photo.”, a possible approach considered might be to enable it through the association of a cartoon depicting that emotion to the photo. However, its success might depend on Nuno's ability to recognise his own emotions (Griffiths et al. 2017) and the emotion depicted by each cartoon character. Therefore, this scenario makes an explicit consideration of Nuno associating an emotion to the photo, and such approach can then be accepted, complemented or challenged by any team member, as was our case, leading to the additional pursuit of an Affective Computing Henriques et al. (2018) approach to complement (by using biometrics to automatically infer Nuno's emotion), at a later stage, the approach assumed in the scenario.

Similarly, another explicit option, depicted in the scenario, is the integration with Facebook. While Nuno uses the envisaged system to post on his diary, making use of the provided communication aids, his friends can see the contents through Facebook. The discussion leading to this option considered evidence on the positive influence social

media may have on children with ASD (van Schalkwyk et al. 2017), the potential interest of performing some degree of adjustment on how Nuno can interact with the social media platform, and the ability of other users joining in without the need to adopt the same application.

Finally, considering the scenario and the characteristics of the Personas, it is possible to define a list of requirements that should guide the development of a first prototype, the scenarios providing the context and sequence in which they should be available. For instance, a subset of first requirements can be: (a) take photos; (b) automatically store the photos taken; (c) delete photos; (d) edit the photos to assign an emotion and add a description; (e) share the photos in a diary; (f) show what was posted, in a timeline; (g) enable accessing the daily schedule; (i) third-parties, e.g., parents and teachers can add information; the information contained in the diary should be viewable remotely, by others, (j) avoid information overload by avoiding too many choices to be made or multiple contents presented at the same time; (k)

**Table 6** Persona for Sara Vieira, a speech therapist

## General information



**Sara Vieira** was born in Branca, Albergaria-a-Velha county, Aveiro district, on the 16th of January, 1983. She is married to João Vieira and has a one year old daughter.

She has both a BSc and an MSc in Speech Therapy, specializing in Speech-Language Pathologies. She currently attends the PhD in Linguistics, specializing in Linguistics for Diagnosis and Intervention. She was responsible for organizing and teaching two modules in the postgraduation course “Language Disorders in Children, namely: “Music’s Influence in Language Development - Interventions in Speech Therapy” and “Fluency Disorders”.

Academic background and competences

Besides being a Speech Therapist, Sara also teaches music in daycare facilities and kindergartens to children aged 4 months up to 6 years. In 2012, she started working at the Structured Teaching Unit for students with ASD of Anadia’s elementary school. Before that, she worked at the Centre for Education and Rehabilitation of Citizens with Disabilities, where she also worked with children with ASD. Since all her professional experience includes working with children diagnosed with ASD she has acquired a good level of knowledge in this intervention area.

Relevant professional experience

Taking into consideration that music has a strong potential in child development, namely due to its influence in communication and language, Sara uses it quite often during therapeutic interventions. She sees herself as joyful, caring, friendly, happy and adventurer. Her main interests span across literature, music, and dance. In her free time she plays transversal flute and attends classic and modern dance classes.

Intervention approaches

**Motivation:** Sara would like to increase Nuno’s communicative intentionality along with an improvement of his ability to talk about his day-to-day life.

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simple to use; (1) and use a simple language and self explanatory icons.

The conceptualisation and specification process of the application is then structured based on the requirements, always keeping in mind the family of Personas, their motivations, and the scenarios. As an example, Figure 1 shows some screen shots of a prototype application stemming from this family of Personas and presented scenario and developed to explore different ideas in the context of project IRIS (Vieira et al. 2017).

## Discussion

The methods proposed in this article are not meant as a complete description of the full work needed to gather the information to build the Personas or a full account of

the complete set of scenarios to properly describe how the envisaged system helps the different Personas pursue their goals. The purpose is to make a case for the need to have a systematic method to discuss and convey the contexts and approaches considered for researching technologies for individuals with ASD and illustrate the outcomes of applying such method.

## A Family of Personas

The presented family of Personas reflects a particular set of people, their characteristics and motivations, composing a specific context. For different contexts and application scenarios, the Personas might share some of the characteristics with those presented here, might differ, in particular aspects, or be enriched with novel information, for instance, regarding how the individual with ASD deals with anxiety.

**Table 7** Persona for Sofia Rodrigues, a regular education teacher

## General information



**Sofia Rodrigues** was born in Aveiro on the 3rd of May, 1989. She is single and lives with her parents.

She has a BSc in Elementary Education and an MSc in Pre-school and Primary School teaching. She has also attended courses on “Detecting Child Abuse” and “Sign Language - Level I”.

Presently, she teaches 4th grade students in Anadia’s elementary school. She has two years of teaching experience, but she only had a child diagnosed with ASD integrated in her regular class for the past seven months. Since her class has approximately 20 students she mentions that it is hard to provide all the support that her student with ASD requires.

*[Beyond that, the student with ASD constantly defies her authority refusing to enrol in the proposed tasks and frequently showing opposing behaviours such as shouting and tearing or piercing the worksheet with a pencil. Only on very rare occasions the student establishes eye contact or interacts with her on his own initiative.]*

In this context, she is not able to perform an active role in his teaching when compared with the special education teacher. In the future, she would like to improve her knowledge in this intervention area.

*[She already tried to use an application to provide the child with ASD with some features that might help during class, but sometimes she struggled with having to deal with the fact that the application was not also used by the remaining students.]* Her main interests include literature, cinema and painting. In her free time, she likes swimming and handicraft. During weekends, she regularly hikes.

**Motivation:** Sofia would like to play a more active role in the development of Nuno’s competences and be able to have a richer interaction with him.

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Another aspect that can be explored is the proposal of a more diversified set of Personas covering, for instance, different levels of functioning (Antle 2008) for the child with ASD, other ages (e.g., Gotham et al. 2015, ), or additional members of the family, such as grandparents (Hillman et al. 2017).

It is important to emphasise that we are not proposing that the design and development for individuals with ASD should be limited to the use of families of Personas. There are several methods that bring the individual and, to some extent, stakeholders into the design process (e.g., participatory design (Gaudion et al. 2015; Fabri et al. 2016), emancipatory design (Chown et al. 2017) or domain-specific guidelines (Börjesson et al. 2015; Fletcher-Watson et al. 2016)), a notable recent example being the work by Huijnen et al.

(2017) regarding how to implement robots in intervention. Personas stand as an asset for discussing motivations and abilities, for gathering contributions by people with different areas of expertise and interests, and as an instrument to communicate aspects of concrete research contexts and findings to others. As very well put by Frauenberger et al. (2012), “methodological thoroughness and transparency in making design decisions are key to justifying the outcomes and getting every member of a multi-disciplinary research team to embrace the design.”

### Multidisciplinary Collaboration

The family of Personas presented, along with the scenario example, have resulted from an effort involving people

**Table 8** A scenario describing a part of Nuno's day and illustrating how he can use a system to help him communicate and learn

**“Scene 1: Sharing content with family and friends** Nuno just finished the activity he was performing in his Speech Therapy session and wants to take a photo to keep a memory of the moment and share it. To do it he accesses the application and presses the icon corresponding to the photo camera, available on the main screen. The application takes the photo and automatically saves it. Next, the application shows a new menu allowing Nuno to associate an emotion to the photo, describe what he was doing using different message input alternatives, and share it on his diary. In the diary, the information is shown by order of occurrence along with the day and time of insertion. While his parents and remaining carers can use the application to see the photos and comments shared in the diary, his friends can simply access Nuno's Facebook profile to see and react to the contents. **Scene 2: Completing a Mathematics exercise** A little time after, Nuno goes to school and, when he checks his schedule, notices that the next activity involves doing some math exercises. Taking into consideration that this is an activity that Nuno does not appreciate very much, his Special Education teacher uses a Quiz, available on the main screen, to turn it into a more joyful task to improve Nuno's motivation and participation in the proposed activity. Using her own device, the teacher prepares the different questions and response options and sends them to Nuno's tablet. When Nuno chooses one of the options, the system informs him if he got it right. When Nuno takes some time to answer, the teacher makes an animated cartoon character, presented during the quiz, say something motivating or to help him find the answer. **Scene 3: Reacting to other's inputs**—After finishing his exercises, Nuno decides to check his diary. The photo he had shared previously, taken during his therapy session, already has a comment from his mother congratulating him for his work. Nuno reacted with happiness and asks the teacher for some help in answering his mother's comment. **Scene 4: The mother checks information about Nuno's day and chores** The mother, having a break at work, has just seen and commented on Nuno's photo. Quite often, the mother also feels the need to know more about Nuno's homework to enable her to motivate him and provide the best help possible. For this reason, the different professionals who work with Nuno can use a specific section, in the application, to include information for parents, e.g., a daily success or difficulty and a description of the home work.”

**Fig. 1** Example screenshots of “Tell Your Day”, a first prototype application exploring alternatives to implement the scenario in Table 8. From left to right, the login screen, the association of an emotion to a photo, and a quiz screen for an exercise question prepared by the teacher

with very diverse backgrounds and perspectives regarding the child with ASD (speech therapists, teachers, human-computer interaction engineers and software developers). From the start, the process was led by a speech therapist with experience working with children with ASD. The first version of the Personas, based on the literature and on contributions by the team members, was subsequently discussed with a panel of experts including professionals represented in the Personas and with experience working with children with ASD. These experts were not involved in the first stage and had no trouble in understanding (and contributing to) the Personas considering them a good depiction of the different stakeholders.

The narrative form of the Personas and scenarios enabled collaboration at the higher level, motivating each team member to translate the ideas from his/her area of expertise into its impact on the user's behaviour and motivations, more easily understandable by all. Additionally, Personas and scenarios make the path from motivations and needs to requirements more explicit and traceable: a particular motivation, addressed in a specific scenario, leads to certain requirements and the sense of this route can be analysed, disputed, or offered alternatives by different researchers

and professionals. This can also be potentially helpful in fostering a more translational nature of the research getting it closer to industry partners, which can play a vital role in the desirable dissemination of the proposed interventions (McCleery 2015).

### A Family of Personas as a Dissemination Resource

Providing the considered Personas and context scenarios explicitly (as the ones we present here) or by referring to the literature where they are detailed and highlighting differences, for the sake of brevity, enables a richer context for any work presented. This, delivers a characterisation of what has been accomplished, with whom, and to tackle which motivations (and to what degree), fostering learning with each experience and a solid stage from which to evolve (Lubas et al. 2014; Benton et al. 2015; Hendriks et al. 2015; Fletcher-Watson 2015). The Personas and scenarios can serve as grounds for discussion for novel works: how well do these Personas fit our context? How do the motivations from our stakeholders make our work different from related work? Is a particular approach described in the literature serving those motivations? Are we focusing



on a different user group? How does our envisaged context scenario differ from previous ones? Do we address a similar context, but considering different technologies or usage scenarios? Considering the depicted motivations, scenarios and requirements, can we offer alternative approaches?

It can be argued that, for the purpose of dissemination, Personas might be provided in a more compact format, e.g., as a list of relevant aspects, such as in McCrickard et al. (2015). However, this would filter several aspects that foster a greater insight into the users and contexts: (1) those that trigger empathy and establish the Persona as believable; and (2) those that provide a more culture-specific flavour to the Personas and scenarios, an important asset during design and development (Frauenberger et al. 2015). In several research domains, it is common practise that the data considered or gathered during research is made available for the community, fostering transparency, replicability and a greater understanding of what has been accomplished. Personas and scenarios can just be treated as any other research data set and an integral part of the work that is made available for others.

### Analysis from the Social Science Research Perspective

Proposing Personas, along with scenarios, as relevant tools for dissemination of research contexts, motivates their discussion addressing social and design research criteria (Antle 2008; Wärnestål et al. 2014), a set of qualitative aspects covering objectivity, dependability, credibility, relevance and transferability.

For objectivity we need to consider if the Personas and scenarios will be representative of the characteristics of the stakeholders rather than a particular view of the designers. The Personas rely on data provided by the literature, on observation, and include input from the stakeholders, reducing the possibility of personal interpretations by the designers. Moreover, the family of Personas is a tool for discussions with stakeholders and among the team members, desirably with different backgrounds, and this should provide a more balanced, holistic view of each of the Personas. The family of Personas opens space for the different stakeholders to assume their own motivations instead of mixing them as those of the child, which clarifies from where motivations and, indirectly, requirements come from.

Dependability refers to the repeatability of the proposed approach. The creation of new Personas for other projects, following a similar methodology (Cooper et al. 2007; Adlin and Pruitt 2010), is possible. Nevertheless, it should be noted that the resulting Personas are not expected to be similar as it depends on the context of the work and on the considered stakeholders. Naturally, the Personas will flourish from the available data, stakeholder input and designer

team experience. Additionally, they will evolve towards providing the best possible information relevant for the context at hand. The idea is not that all the Personas should be equal, but that they are there for us to assess the differences and similarities among studies.

Regarding credibility, the proposed Personas are subjected to validation and discussion by stakeholders and experts. The fact that Personas include a characterization in narrative form enables an easier dialogue among stakeholders as the focus is on behaviours, abilities and limitations, instead of technical sophistication (Frauenberger et al. 2012). To ensure the best possible internal validity, the family of Personas should be subjected to the analysis and open discussion with multiple people inside and outside the design team. By making the family of Personas as a tool for dissemination, they are also subject to the analysis by peers.

Another point that can be discussed is relevance, i.e., the extent to which a family of Personas for an individual with ASD can address aspects in such a way that it improves the design process. The family of Personas explicitly brings forward the characteristics and motivations of the different stakeholders instead of blending them in a single Persona, typically the individual with ASD, making it clearer to the design team. It also provides a common ground, along with scenarios, for discussion among multidisciplinary team members where, instead of sticking to their field's technical language (e.g., Engineering or Psychology), they can translate it to behaviours and abilities more easily understandable and discussable by all. This will potentially address a more customized user centred approach (Antle 2008). Finally, it makes the context, stakeholders and approach more easily disseminated, contributing to a clearer depiction of application contexts (Benton and Johnson 2014), design decisions, and research outcomes.

Transferability should be looked at with care. As noted, when addressing dependability, a Persona is specific to a context and targeted users and stakeholders. Therefore, transferring Personas among contexts should be performed with care. Nevertheless, the Personas presented for one work can be used as the basis for other works and adapted accordingly, based on specific evidence and team experience. For instance, if a Persona already exists for the Portuguese context (as presented in this proposal), its overall characteristics (e.g., regarding communication capabilities) can be adopted and complemented with information for the specificities of interest. Note that one of our arguments is precisely that Personas can be used to communicate the specifics—evidencing differences and common ground—of each work. Although a family of Personas, as the one we present, for a particular context, might not cover the context for other projects, it may be a good starting point for designer teams to get acquainted with an overall characterization of the stakeholders, developing greater sensibility towards what is at stake.

The capacity of communicating the specific design context (Benton and Johnson 2014), whom did we address, what where their characteristics and motivations, how we balanced them and how our proposal was used, through scenarios, is an important aspect that, together with proper evaluation of the outcomes (e.g., acceptability, and impact during intervention) can help move towards a sustainable evidence based evolution of the field.

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## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Research Involving Human Participants and/or Animals** This article does not contain any studies with human participants or animals performed by any of the authors.

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