“Developing and implementing a framework for evidence-based practice for technology relevant for autism”

Final Report

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I.1 Foreword

Throughout this document, we use the term autistic community to refer to people who have a diagnosis of autism and autism community, to refer to the broader community affected by autism, including families and care-givers. Close collaboration between academic researchers and stakeholders from the autism community was crucial to our research project. We opted for a participative approach where experts from the autistic and autism communities were asked to co-construct a methodological framework with the research community to address issues related to digital technology for autism.

During the last two decade, parents, clinicians and researchers have noted the great benefit of digital technologies as therapeutic and educational tools for people with Autism Spectrum Disorders (ASD). The clinical and scientific literature emphasizes the assets of technology for supporting autistic individuals, such as offering a predictable environment, rich stimulations, reduced social demands and portability. There are however potential risks that need to be acknowledged, such as excessive use, risks of neglect or the rapid obsolescence rate of technology. Harm can also be caused by

wasting resources, in terms of time and money, on interventions which do not deliver benefit and are not efficient.

Until now, the autism community lacked a mechanism whereby autistic individuals or their care-givers could easily gauge whether a technology was beneficial and assess possible harm. Due to the exponential proliferation of technological supports for autism, the current situation is one where commercially available digital supports are often not evidence based whereas technological supports with an evidence base are not commercially available. The autism community is therefore in need of a practical framework to be able to identify evidence-based practices in the field of technology-based supports. Expertise on the matter can be drawn from academic research, but should also be sought from the autism community itself.

With the autism community, we co-developed an accessible framework to enable an understanding of the evidence base for digital interventions. To enable the autism community to effectively contribute to the co-design of the EBP framework, we used an anonymous online participatory design that enabled experts originating from the autistic and autism communities to work with researchers on equal standing. Together, they were able to make recommendations for how digital technologies can facilitate inclusion and promote respect for autistic people.

I.2 Project summary in English

Introduction: There has been an exponential increase in the availability of digital technologies to support the autistic community. However, there is no mechanism for users and their caregivers to easily access evidence demonstrating that such technologies are beneficial. According to recent scholarly reviews, digital technologies for autism with an evidence base are not commercially available, and commercially available technologies often lack a solid evidence base. Evidence-based practice (EBP) is central to medical disciplines and is increasingly being extended to psycho-behavioral interventions for autism. EBP has been instrumental in promoting and standardizing evaluation methods such as Randomized Control Trial methodologies. In the present project, we sought to co-develop with the autistic community a framework for assessing evidence supporting technology-based interventions.

Methods: Our methodology was twofold: (1) We developed a scale, called User-Centered Design for Support (UCDS), to assess the extent to which the design of a digital technology is informed by empirical data, autism domain expertise and the scientific literature. We evaluated our scale and an EBP scale specifically designed for autism interventions in a randomized sample of 211 relevant published reports. (2) We conducted a Delphi study to elicit recommendations from a panel of experts (researchers, developers, autism community) on digital technology interventions for autism.

Results: Inter-Rater Reliability for the two tested scales was good to excellent and the UCDS classification of weak and strong studies had high correspondence with an independent human expert. The majority of reviewed articles received a “weak” EBP rating and a medium to low score on the UCDS scale. The Delphi study yielded recommendations for improving the following three aspects of technology for intervention: reliability, engagement, and efficiency.

Discussion: The framework and scales we developed, and the resulting recommendations we received, can help members of the autism community determine the evidence base before adopting technology-based interventions.

1.3 Résumé du projet en Français

1.4 Introduction

In line with the preferences expressed, we use the term autistic community to refer to people who have a diagnosis of autism and autism community, to refer to the broader community affected by autism, such as the families/ care-givers (Kenny et al., 2016). People of all ages within the autistic community can have an affinity for using digital technologies and these can be beneficial in delivering educational and therapeutic content (Fletcher-Watson, 2014; Shane & Albert, 2008). Research shows that digital technologies are used by autistic children around 2-3 hours per day outside of school-time but there are concerns among care-givers about the suitability of these technologies (Kasari & Smith, 2013). There has been an exponential proliferation in the availability of digital technologies to support the autistic community, with no mechanism by which they, or their care-givers, can easily use evidence to gauge whether such technologies are beneficial, or indeed to assess possible harm.

Evidence-based practice (EBP) is central to medical disciplines (see (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996a)) and has been extended to psycho-behavioural interventions for autism (Mesibov & Shea, 2011a). Digital technologies are relatively new and urgently require their own EBP framework to enable application of the supporting evidence in an accessible manner. With the autistic community, we co-developed an accessible EBP framework to enable an understanding of the evidence base for digital interventions.

1.5 Literature review synthesis

Technology-based supports are digital technological products used as therapeutic, educational, or accessibility tools (Durkin, 2010). This can include the use of technologies with a leisure function, to facilitate participation and deliver quality of life. Members of the autistic community find them particularly acceptable (Frauenberger, 2015) and there has been an exponential increase in the number of technology-based supports for the autistic community (Faja et al., 2012; Ploog, Scharf,

Nelson, & Brooks, 2013). In the past decade, technology-based supports for autism have gone considerably beyond the use of simple desktop computers. They now involve robots (Billard, Robins, Nadel, & Dautenhahn, 2007; Dautenhahn, 2003), touch screen devices (Cihak, Wright, & Ayres, 2010), speech generating devices (Blischak & Schlosser, 2003), virtual reality (Bradley & Newbutt, 2018; Mesa-Gresa, Gil-Gómez, Lozano-Quilis, & Gil-Gómez, 2018; Parsons & Cobb, 2011; Parsons & Mitchell, 2002), tangibles (van Dijk & Hummels, 2017) and wearables (Escobedo et al., 2012; Taj-Eldin, Ryan, O'Flynn, & Galvin, 2018). At the same time, parents / caregivers often worry about their autistic children (young people or adults) spending too much time on digital technology (e.g. games and social networks), expressing fears about obsessive behaviors or social isolation (Finkenauer, Pollmann, Begeer, & Kerkhof, 2012; Fletcher-Watson et al., 2019; Laurie, Warreyn, Uriarte, Boonen, & Fletcher-Watson, 2018). It is therefore particularly pertinent for this group that technology-based supports are selected based upon strong evidence of effectiveness and that they are designed with autistic users in mind.

Although the results of studies evaluating technological supports vary in terms of the benefits for autistic people, the overall findings seem rather encouraging. Technology-based supports often result in benefits such as increased motivation, decreases in external signs of anxiety or distress, increased attention and sometimes increased learning compared to traditional methods (Goldsmith & LeBlanc, 2004). Educational and therapeutic technologies have been shown to be beneficial in the areas of social communication (Ramdoss et al., 2011), emotion recognition (Berggren et al., 2018; Bolte et al., 2006; Faja et al., 2012; Silver & Oakes, 2001) and academic skills acquisition and improvement (Massaro & Bosseler, 2006; Pennington, 2010). Technology, both in school and home settings, is being used in a variety of supportive ways such as for increasing independence, reducing anxiety, and creating social opportunities for autistic young people (Aresti-Bartolome & Garcia-Zapirain, 2014; Brosnan & Gavin, 2015; Brosnan, Good, Parsons, & Yuill, 2019; Hedges, Odom, Hume, & Sam, 2018; Odom et al., 2015). With the advent of tablets and smartphones, digital technologies became easier to use and accessible for a broader range of the autism spectrum, including very young children and individuals with lower reading and language abilities (Laurie et al., 2018). Studies have also reported participant eagerness to engage with technology (Moore & Calvert, 2000; Williams, Wright, Callaghan, & Coughlan, 2002) and high rates of participants staying on task (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Heimann, Nelson, Tjus, & Gillberg, 1995).

However, although we find widespread evidence of positive outcomes from using technology to support autistic people, the quality of this evidence remains low (Grynszpan, Weiss, Perez-Diaz, & Gal, 2014; Kim, Nguyen, Gipson, Shin, & Torous, 2018) and rarely meets standard quality criteria for Evidence-Based Practice (Kitchenham, Dyba, & Jorgensen, 2004; Sackett, 1997). Evidence Base Practice (EBP) as

applied in healthcare describes the integration of best available research, clinical expertise, patient values and circumstances and health care system policies (Dijkers, Murphy, & Krellman, 2012). If a practice is not evidence-based, it risks being inapplicable to a specific patient, out of date or even potentially harmful to the patient. Evidence of efficiency is based on relevant scientific methodologies, with meta-analyses and randomized controlled trials (RCT) being considered as the "gold standard" methods (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996b). Wong et al. (2015) showed that from 29105 articles originally identified reporting on supports for autism, there were just 27 focused practices that met criteria for evidence-based practice (EBP).

Even applying less rigid quality criteria, the current state of the evidence base for technological supports for autistic people is weak. For example, Reed, Hyman and Hirst (2011) reviewed technology-based applications to teach social skills to autistic children, finding that while almost all of the studies (96.6%) provided an operational definition that would allow for replication of the procedures, only four studies (13.8%) monitored and reported treatment integrity data. None of the studies used a published social skills assessment and reporting on reliability of the independent variables was infrequent. Ramdoss et al. (2011) systematically reviewed the use of computer-based communication interventions for autistic children for their certainty of evidence. Conclusive evidence was found for only two studies, whilst two others had preponderance level of certainty and six had suggestive evidence. A meta-analysis conducted by Grynszpan et al. (2014) identified only 22 pre-post group design studies out of 379. Their findings indicate that digital supports can be effective for autism but only a very small proportion of the evidence from group-design studies (6%) provides sufficient evidence to make an informed decision whether to use a digital support.

Although the field of technology for autism largely lacks evidence from RCT, there are signs that this gold standard methodology is becoming more commonplace (Beaumont & Sofronoff, 2008; Bolte et al., 2006; Faja, Aylward, Bernier, & Dawson, 2008; Faja et al., 2012; Fletcher-Watson et al., 2016; Gilroy, Leader, & McCleery, 2018; Golan & Baron-Cohen, 2006; Hopkins et al., 2011; Tanaka et al., 2010; Voss et al., 2019). Two of these studies (Beaumont & Sofronoff, 2008; Fletcher-Watson et al., 2016) report on the use of computer assisted learning to teach face or emotion recognition. A recent RCT (Gilroy, Leader & McCleery, 2018) has been published comparing a conventional (low-tech) version of the Picture Exchange Communication System (Bondy & Frost, 1998) with an open-source digital (high-tech) version (called FastTalker). And yet another recent RCT (Voss et al., 2019) has found significant improvements on socialization for participants with ASD receiving intervention with Superpower Glass, an artificial intelligence–driven wearable behavioral intervention. However, this development is somewhat undermined by the observation that supports having robust evidence of effectiveness are rarely commercially available, whilst commercially available therapeutic

technologies are infrequently evaluated in research (Constantin, Johnson, Smith, Lengyel, & Brosnan, 2017; Ramdoss et al., 2011). For example, from an analysis of 695 commercially available apps for autism, only 5 (<1%) were found to be supported by direct evidence (Kim et al., 2018).

1.6 Project methodology

To address this point, we employed a twofold methodology: First, we developed a scale, called the User-Centered Design for Support (UCDS) scale, to assess the extent to which a technological design was informed by empirical data involving the end-users and we tested this scale along with an EBP scale developed by Reichow, Volkmar and Cicchetti (2008) on the literature about technology-based interventions. Second, we conducted a Delphi study to elicit recommendations from a panel of experts on digital technology interventions for autism. The Delphi method is a consensus building technique where experts anonymously rate and reformulate statements through an iterative process managed by a moderator.

The relatively low quality of evidence regarding clinical studies in autism is not specific to technology-based supports (Green & Garg, 2018). Given the importance of educational approaches in autism support practices, authors argue in favor of a more balanced range of methodologies to be considered in EBP (Guldberg, 2017; Mesibov & Shea, 2011b). To address this issue, Reichow, Volkmar and Cicchetti (2008) designed a method to assess the strength of evidence specifically for studies focused on autistic children that can be applied to group study designs or to single subject experimental designs (SSED). We regarded this evaluative method as an appropriate first step to promote EBP in the field of technology based support for autism and we employed it in the present study to review the current literature.

Numerous studies evaluated the effect of using technological programs on outcome measures and yet only sometimes discussed their design process (Fletcher-Watson, 2014). We therefore often lack the information to assess whether it is poorly designed technology-based supports that may result in a lack of learning and we might erroneously conclude that technology-based supports are a poor educational method. Decision on whether to acquire a piece of technology should therefore be guided by evidence about the quality of the design, in addition to evidence about its efficacy. Technology-based support requires not only a robust evidence base, but also the involvement of the autistic community in the research and development process (Brosnan, Parsons, Good, & Yuill, 2016; Parsons, Yuill, Good, & Brosnan, 2019; Pellicano, Dinsmore, & Charman, 2014) (Brosnan et al., 2016; Fletcher-Watson et al., 2019; Pellicano et al., 2014) to ensure the needs of the autistic community are satisfactorily met. We argue that any EBP framework for technology development should incorporate an evaluation of this kind of User-Centered Design (UCD) (Kitchenham et al., 2004). UCD is an iterative

design approach based on explicit understanding of users, tasks and environments, driven by user evaluation and including multidisciplinary perspectives, for which a range of methods for testing prototypes and involving potential users in the design process have been developed (Jordan, 2003). To our knowledge, scaling instruments to evaluate the quality of design in a user-centred perspective do not exist. We thus had to create one from scratch. We called it the User-Centered Design for Support (UCDS) scale.

As EBP is informed by the integration of the best research evidence with practitioner expertise and the values of the recipient of the practice involving both practitioners and the autism community within the consideration of research evidence is therefore essential to EBP (see also Fletcher-Watson et al., 2019; Parsons et al., 2019). With this study we aimed to co-develop a framework for evaluating the evidence base for digital supports for autism, through a better understanding of what constitutes evidence for the autistic and broader autism communities and what sources are being used to obtain that knowledge when considering digital supports for autism. We used an online, four-round Delphi Study methodology, ideal for integrating the perspectives of multiple stakeholders (Hasson, Keeney, & McKenna, 2000), with feedback managed by a moderator at all stages (Trevelyan & Robinson, 2015). The Delphi study methodology was selected as it has been proposed to be more effective for group-based judgment and decision-making than traditional group meetings by both increasing a group's access to multiple interpretations and views and decreasing negative features of group discussions such as domineering individuals and opinions (Belton et al., 2019; Hasson et al., 2000; Rowe & Wright, 2001; see also Humphrey-Murto & de Wit, 2019). The Delphi methodology was therefore chosen as an ideal format for systematically capturing and integrating opinion from a diverse group of experts, who are not co-located and remain anonymous from each other (Goodman, 1987; Hsu & Sandford, 2007). Since the method allows each individual to contribute anonymously and in their own time, the study allowed us to accommodate different communication preferences that do not include in-person communication and to avoid direct confrontation between people of differing opinions. Allowing participants to contribute at their own pace without having to manage live group discussions therefore made it easier to include autistic individuals.

Four key groups of stakeholders were identified: 1) autistic people; 2) families of autistic people; 3) professionals who support autistic people; and 4) Researchers – all with experience of using or developing digital supports for autism and advising others on the topic (see Table1).

Table 1. *Number of panel members per round*

Round	Community members			Researchers	Total per round
	Autistic People	Family members	Professionals		
1	6	8	13	-	27
2	6	7	11	-	24
3	5	2	6	12	25
4	5	2	5	11	23

The study was conducted using an online survey software (www.qualtrics.com) over four rounds (Table 2). A literature review was conducted on evidence-based practice for digital supports for autism providing information about the goals of existing digital supports. These informed the design of the first round of the Delphi Study, providing context for panel members to consider how they may seek sources of potential evidence. Panel members' comments and ratings in each round were collected and analyzed by the moderator, and used to create content for the following round.

Table 2. Goals and panel members in each round

Round	**Description**	**Panel members**
1	Brainstorming: Open enquiry about the reasons for using digital supports and the kind of information used to select digital supports.	Family members Professionals - Practitioners Autistic people
2	Categorisation of evidence: Organise evidence in categories, locate new types of evidence	Family members Professionals - Practitioners Autistic people
3	Drafting the framework: Ranking and editing lists of statements about evidence	Family members Professionals - Practitioners Autistic people Researchers
4	Finalisation: Ranking a selection of the statements and final modifications in wording	Family members Professionals - Practitioners Autistic people Researchers

1.7 Results and discussion

To our knowledge, this was the first study to develop an instrument to evaluate user-centered design for technology-based supports for autism. The inter-rater agreement for the application of the UCDS scale was in the range of excellent values (Hallgren, 2012). Additionally, there was complete agreement between scores obtained on this scale and how an independent expert in user-centered design classified studies as of high or low quality. These results are good indications of the relevance and applicability of this scale to evaluate the technological design for autism.

When deciding which support is the most appropriate one for a person, a variety of factors is taken into consideration, evidence being only one of them (Dijkers et al., 2012). The weight of evidence in the decision process is modulated by other factors like societal values and personal preferences. The level of required evidence depends on the personal goal of using a specific piece of technology. For instance, digital products can be used for the element of fun, in which case stringent evidence criteria may not be critical. In such circumstances though, ease of use and adequacy with the user's requirements will be pivotal to the decision making process. Assessment of the evidence base of a technological support should thus be accompanied with the evaluation of how users were involved in the technological design process. Combining evaluations with Reichow's scale and the UCDS scale should be instrumental in providing a more complete assessment of the suitability of technology-based supports. Additionally, the rapid development of technology-based supports often prevents careful evaluation using long RCT due to a mismatch between the timelines of commercial and academic progress (Fletcher-Watson, 2015). When this is the case, the UCDS scale could still be used to evaluate to which extent the design process was informed by evidence and autistic users' experience.

This was also the first study to generate a consensus from an international group made up from the autistic and broader autism communities as well as researchers as to what constitutes good evidence for digital supports for autism. Through a Delphi Study methodology, consensus was achieved on a detailed framework providing the parameters for which evidence is sought and the sources of evidence perceived to be important. This novel framework allows users of digital supports to incorporate evidence into their decision making regarding the selection and use of digital support, for themselves, or their autistic family members, pupils, clients, participants etc. The framework can also inform those developing digital supports for the autistic community, highlighting what types of evidence are considered important. For the first time, the autistic and autism communities can incorporate evidence-based practice into the development, application and use of digital supports. Importantly this framework has been co-developed through a participatory research approach which connects researchers with relevant autistic and broader autism communities to achieve shared goals. These methods can deliver results that are relevant to people's lives and thus likely to have a positive impact (Fletcher-Watson et al., 2019; Parsons et al., 2019).

1.8 Recommendations

The checklist below summarizes the framework that can be used to evaluate the evidence associated with technologies for autistic users.

Is It Reliable?

The efficacy of a product at the level of engineering. Is it technically sound / functional? How well does it work? e.g. Does the recognition functionality actually work? Does the app crash often?	
1	**Try it out.** *You might request a trial version from the developer, or borrow a copy / device from a friend. Take your time to explore all the functionalities. Ask how the trial version differs from the full version.*
2	**Get an expert opinion.** *Talk to relevant professionals (for example a specialist teacher, speech and language therapist, specialist psychologist, etc.). Ask (autistic) people, organisations or agencies you know who have specialist skills and relevant experience with technology.*
3	**Read online reviews.** *Look on app review websites and social media. Include reviews from autistic users and their families and pay attention to people that have been using the product for a (relatively) long time. Read and compare as many reviews as possible to improve objectivity. Keep in mind that reviewers' circumstances (e.g. their needs, age, goals or budget) may not be the same as yours and individual experiences may not be generalisable.*
4	**Seek academic opinions.** *Read an academic article evaluating the product, or find an article/online talk in the mainstream media by a qualified scientist. Check the academic's relevant qualifications, affiliations and potential conflicts of interest when you decide how much trust to put in them.*

Is It Engaging? *The user perception of the technology. How usable, agreeable, pleasant and accessible a product is for the specific users? Its ease of use / look & feel.*	
1	**Try it out.** *You might request a trial version from the developer, or borrow a copy / device from a friend. Explore all the functionalities and see if it might be motivating to keep using it in the medium and long term, as well as the short term. Ask how the trial version differs from the full version.*
2	**Read online reviews.** *Include reviews from autistic users and their families and pay attention to people that have been using the product for a (relatively) long time. Keep in mind that reviewers' circumstances (e.g. their needs, age, goals or budget) may not be the same as yours and individual experiences may not be generalisable.*
3	**Get an expert opinion.** *Ask people you know who have skills and experience with this technology and/or autistic users. Talk to relevant professionals such as a as a teacher, therapist or support worker. Ideally look for someone who also knows you as your personality has a key role in how engaging you will find it.*

Is It Effective? *The outcome of using the product. How much impact does it have to the people using it? Does it make an observable*	

	difference in the user's life/behaviour?
1	**Read an academic paper.** *Ideally look for a review that systematically combines the results from multiple independent studies. It may be worth checking the quality and potential affiliations/bias of the original studies too and the journals where they were published.*
2	**Get an expert opinion.** *Talk to relevant professionals (for example a specialist teacher, speech and language therapist, specialist psychologist, etc.). Ask (autistic) people, organisations or agencies you know who have specialist skills and relevant experience with technology.*
3	**Read online reviews**. *Include reviews from autistic users and their families and pay attention to people that have been using the product for a (relatively) long time. Keep in mind that reviewers' circumstances (e.g. their needs, age, goals or budget) may not be the same as yours and individual experiences may not be generalisable.*
4	**Try it out.** *You might request a trial version from the developer, or borrow a copy / device from a friend. Take your time to explore all the functionalities. Ask how the trial version differs from the full version.*

1.9 Application supports presentation

A website (www.beta-project.org) has been developed to host the application supports, which are all openly accessible. Application supports (except videos) can be found in the accompanying documents. These documents are stored in three different folders according to their language: EN for English, FR for French and ES for Spanish. These documents are listed and described in the table below. This table uses serial numbers to identify the different application supports.

Number	Application support	Document name
1	Review of the literature in French to be made publicly available online on the FIRAH website.	FR: revue littérature FIRAH_v3.docx
2	Recommendations for facilitating inclusion of autistic participants in co-design. These recommendations	EN: English-Facilitating-inclusion-in-co-design-through-online-communication.pdf FR: Français-Faciliter-l-inclusion-dans-la-co-conception-par-le-biais-de-la-communication-en-ligne.pdf

	were drawn up from our experience in implementing the Delphi study.	
3	A collaboratively developed framework on how to find evidence for digital products for autistic users.	EN: 4_THE_FRAMEWORK.pdf FR: 4_CADRE_METHODOLOGIQUE-1.pdf ES: 4_EL_MARCO_METODOLOGICO.pdf
4	Words of caution about evidence-based practice for technology for autism. This document lists possible risks or constraints associated with the developed EBP framework.	EN: 3_WORD_OF_CAUTION.pdf FR: 3_PRECAUTIONS.pdf ES: 3_ADVERTENCIAS-.pdf
5	Scripts of the videos explaining how to apply the EBP framework	EN: VIDEO_SCRIPT_1.pdf; VIDEO_SCRIPT_2_UK.pdf FR: SCRIPT_VIDEO_1_FR.pdf; SCRIPT_VIDEO_2_FR.pdf ES: VIDEO_SCRIPT_1_ES.pdf; VIDEO_SCRIPT_2_ES.pdf
6	Recommendations for developers on how they may help users find evidence.	EN: 1_FOR_DEVELOPERS.pdf FR: 1_POUR_DEVELOPPEURS-1.pdf ES: 1_LOS_DESARROLLADORES.pdf
7	Introductory lesson on digital technologies used to support autism	EN: 6_SUPPORTING_AUTISME_WITH_DIGITAL_TECHNOLOGIES.pdf FR: 6_AIDES_TECHNOLOGIQUES_POUR_LAUTISME.pdf ES: 6_APOYOS_PARA_AUTISMO.pdf

8	Introductory lesson on Evidence-Based Practice (EBP)	EN: 5_EVIDENCE_BASED_PRATICE.pdf FR: 5_PRATIQUE_FONDEE_SUR_LES_PREUVES.pdf ES: 5_PRACTICAS_BASADAS_EN_LA_EVIDENCIA.pdf
9	Introductory lesson on User Centered Design (UCD)	EN: 7_USER_CENTRED_DESIGN.pdf FR: 7_LA_CONCEPTION_CENTREE_UTILISATEUR.pdf ES: 7_DISENO_CENTRADO_EN_EL_USUARIO.pdf

1.10 Evaluation of the project

The table below presents the list of outputs as defined in the project proposal against their effective implementation. When the implementation is an application support, it is referred to using the serial number assigned in the list of the previous section.

Outputs defined in the project proposal	**Effective implementation of outputs**
Output 1b: Accessible web document detailing the nature of evidence to support digital interventions for ASD.	Review of the literature to be made publicly available online on the FIRAH website: Application support n°1.
Output 1c: Documentation and questionnaires for consultation (based on Reichow rubric) for the co-development of the EBP framework with expert groups (in Phase 2)	This output has been designed on the Qualtrics platform (Qualtrics.com). It was used in the first round of the Delphi study. Note should be taken that this output in not meant for external use, but only for internal use in the project.
Output 1d: Recommendations for facilitating inclusion in co-design through online communication, translated into French and English	Recommendations for facilitating inclusion of autistic participants in co-design: Application support n°2.
Output 2a: An EBP framework, translated in English, French and additionally translated into Spanish	The EBP framework in 3 languages: Application support n°3. Words of caution associated with the framework: Application support n°4.
Output 2c: An end-user friendly web document, developed with the autistic and autism community	The EBP framework can be found in: https://beta-project.org/en/course/
Output 3a: An evaluation of existing digital technologies (including apps) using the EBP	The evaluation of existing digital technologies can be found on an online database:

framework, co-developed with the autistic and autism communities.	https://beta-project.org/en/rated-applications/
Output 3b: Accessible documentation on how to apply the EBP framework to an existing technology, including apps, co-developed with the autistic and autism communities.	Scripts explaining how to apply the EBP framework: Application support n°5
Output 4a: Guidelines for the provision of evidence for research	Two articles have been submitted to international journals. One article described the (UCDS) scale that should help researchers in assessing the literature on digital supports for autism. The other article describes the Delphi study and the EBP framework in a very detailed manner.
Output 4b: Guidelines for the provision of evidence for software/hardware engineers	Recommendations for developers: Application support n°6
Output 4c: A MOOC to support the autistic and autism communities evaluate evidence and implement the EBP framework	A website was constructed to host introductory lessons on digital supports for autism, evidence-based practice and user centered design. The EBP framework and recommendations for developers are also accessible on this website. In addition, this website includes videos that explain how to implement the EBP framework on digital supports for autism. The scripts of the videos are also available. This website includes application supports n°3, 4, 5, 6, 7, 8 and 9. The URL of the website is www.beta-project.org.

In addition, dissemination events were organized in four countries:

- Presentation of the project during the ITASD (Information Technology for Autism Spectrum Disorder) conference on the 2nd of July 2017 in Valencia, Spain

- Presentation of the project during the professionals' AETAPI seminar on February 2nd 2018 in Sevilla, Spain

- Free workshop in Montreal, Canada, on the 1st of May 2019, on the sidelines of the INSAR (International Society for Autism Research) conference.

- Free workshop in Edinburgh, Scotland, on May 17th 2019.

- Free workshop in Bath, England, on May 10th 2019.

- Whole day colloquium in Paris, France, on September 18th 2019 (see program in the accompanying documents).

1.11 Conclusion

The UCDS scale with small modifications could be applied to other conditions than autism and extend to research areas such as mental health and education. User participation in health and education digital support design remains mostly limited to providing feedback to designers' ideas (Danielsson & Wiberg, 2006; Tan, Goh, Ang, & Huan, 2011). Efforts to involve users as co-designers have often been proven challenging due to abstraction ability (Mazzone, Read, & Beale, 2008) of the targeted users. Despite the challenges it poses, with appropriate adjustments, participatory design in the area of technology-based supports has the potential to enable digital empowerment and social inclusion of autistic people (Brosnan et al., 2016).

We applied the framework developed during the Delphi study to a database of digital supports for the autistic community, to identify the level of evidence available (complete, adequate, limited, none) from each source for reliability, engagement and effectiveness. Scores and labels associated with each digital support of this database is freely available on the beta-project.org website. An online version of the framework that enables researchers, developers and the autism community to evaluate the evidence base for any digital supports they are interested in is freely available at beta-project.org. Importantly, this framework identifies the strength (i.e. availability, quality) of the evidence, not the outcome of the evidence. It is possible, for example, that there could be strong evidence that an app is not engaging. For instance, de Vries, Prins, Schmand and Geurts (2015) conducted a RCT trial on a computerised support for training executive functions that yielded non-significant changes associated with high attrition rate in autistic participants, thus discouraging continuing practice. The framework developed here supports the sourcing and consideration of evidence into best practice, not necessarily what that best practice should be.

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