



Appropriateness of the TOBY Application, an iPad Intervention for Children with Autism Spectrum Disorder: A Thematic Approach

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Abstract

This study aimed to explore the appropriateness of an ICT intervention, the Therapeutic Outcomes by You application (TOBY app), from the perspectives of the parents. Parental experiences of twenty-four parents of a child with ASD who had participated in a three-month trial using the TOBY app were collected using semi-structured interviews. Thematic analysis was conducted and themes were mapped against an appropriateness framework. Collectively, parents felt the TOBY app was relevant and important to them and their children's needs, while expressing partial support of the TOBY app as: a positive experience for them and their children, beneficial for them and their children, a socially and ecologically valid intervention, and an intervention that supported change and continuation in the skills learnt.

Keywords Appropriateness · Information technology · Early intervention

Living with a child who has an autism spectrum disorder (ASD) can be challenging for families (Gray 1994; Rao and Beidel 2009). Children with ASD have communication deficits including, but not limited to, difficulty in developing age-appropriate friendships and problems interpreting non-verbal gestures (American Psychiatric Association 2013). Children with ASD also have rigid routines with heightened sensitivity to changes in their environment (Happé and Ronald 2008). There is a growing body of evidence on the effectiveness indicating that educational and behavioural interventions support greater social, economic and community participation for children with ASD. In particular, there is substantial evidence to support the effectiveness of early intensive behavioural interventions (EIBI) for children

with ASD, such as the Early Start Denver Model (Dawson et al. 2010; Howlin et al. 2009). However, the feasibility and appropriateness of these interventions are in question, as they require significant amounts of therapy input (dosage) with highly-trained therapists coming at a considerable financial cost (Whalen et al. 2006).

Information and Communication Technology (ICT) based interventions are emerging as a viable mechanism to provide cost-effective, direct intervention to children with ASD; however, empirical support for them remains limited due to the complexities involved with the development and investigation of these delivery models (Ramdoss et al. 2012; Wainer and Ingersoll 2011). Interventions using a technology delivery system for people with ASD, such as computers and tablets, have made considerable advances in recent times, making them more readily accessible for families (Ploog et al. 2013; Ramdoss et al. 2011). With decreasing costs, increasing ease of use, and children with ASD often having a high affinity for these devices, ICT-based interventions are showing great promise as a potential platform to deliver interventions to children with ASD (Ploog et al. 2013; Tseng and Do 2010; Whitehouse et al. 2017).

Despite the numerous advantages of ICT-based interventions, barriers associated with this type of therapy delivery method need to be considered. The use of ICT-based interventions with this population is associated with decreased social interactions with peers, parents and clinicians, the

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possibility of perseveration on particular items installed on ICT devices, and poor generalisation of skills learnt (Ramdoss et al. 2011). Silver and Oakes (2001) have argued that it is not whether ICT-based interventions are superior to one-on-one interventions, rather, given the constraint of resources, how do we best optimise the use of them in combination with conventional one-on-one interventions?

The Therapy Outcomes By You application (TOBY app) is one such ICT-based intervention. The TOBY app is a tablet (iOS©) delivered intervention tool developed by a team of computer scientists, psychologists and speech pathologists to provide EIBI therapy to children with ASD (Venkatesh et al. 2013). The TOBY app uses an Applied Behaviour Analysis (ABA) framework and is based on EIBI intervention guidelines supporting high-intensity interventions to address individual children's needs using behavioural, educational, and developmental approaches (Prior and Roberts 2012; Venkatesh et al. 2013). The TOBY app syllabus contains four major skills areas: (1) *visual motor*, which targets perception and discrimination of sensory cues, such as colour, shape, sameness and difference; (2) *imitation*, which includes copying an action, design, or pre-speech sounds; (3) *language*, which focuses on the recognition and production of object names; and (4) *social*, which targets inter-personal skills, such as joint-attention (Venkatesh et al. 2013). According to its developers, the strength of the TOBY app is its focus on teaching a parent how to teach (Venkatesh et al. 2013). The TOBY app can be used by parents and their children with ASD without direct input from clinicians; however, it is designed to complement face-to-face therapy.

Two Australian randomised controlled trials have reported on the TOBY app's effectiveness. The first by Whitehouse et al. (2017) reported improvements in visual perception and fine motor skills in children with ASD aged 2–6 years living in Australia, while a second study by (Parsons et al. 2018) suggested the TOBY app improved receptive and pragmatic language in children with developmental ages between two and six living in regional Australia. Both studies reported issues with dosage and intervention fidelity and called for further research into the barriers of the TOBY app use. Participants in the Whitehouse et al. (2017) study completed the intervention for 6 months, with the average use dropping from 19 min over the first 3 months to 2 min in the subsequent 3 months. Notably, participants in this trial received fortnightly calls from researchers to provide support and encouragement. Participants in the Parsons et al. (2018) completed the trial for 3 months, at an average use of 11.3 min per day. Minimal support was provided by the researchers in this trial to improve ecological validity; that is, reduced access to support and follow-up for families living in regional Australia.

With the need for cost-effective and evidence-based interventions, the impact of using resource-intensive

ICT-based interventions from the perspective of the end-user to ensure its appropriateness with the intended client group needs to be explored (Campbell et al. 2000; Craig et al. 2008; Evans 2003; Hammell 2001). Appropriateness can be defined as the perceived fit, relevance, or compatibility of an intervention for a given practice setting, provider, or consumer (Proctor et al. 2011). Evaluation of the appropriateness is vital in the overall appraisal of the value in an intervention, and a qualitative approach through interviews is recognised as an appropriate method to explore the appropriateness of an intervention due to the approach's ability to accurately capture the subjective human experience that is often excluded from experimental research (Evans 2003; Hammell 2001). Moreover, qualitative methods enable researchers to identify the delivery methods and characteristics of therapeutic interventions that best address the needs and priorities of the client, a central tenet in client-centred practice (Hammell 2001). While the evaluation of effectiveness relates to whether the intervention achieves its intended outcomes, appropriateness is more concerned with psychosocial aspects of the intervention than the physiological (Evans 2003). That is, appropriateness is concerned with the impact of the interventions from the perspectives of the recipient. Regardless of the intervention's effectiveness, if deemed unacceptable by the end-user, poor adherence and early abandonment of the intervention may occur, therefore reducing the overall value of the intervention (Evans 2003; Solish and Perry 2008).

Appropriateness, in the context of this study, addresses the experience of using the TOBY app from the perspectives of the parents who participated in a waitlisted parallel randomised controlled trial (RCT) study by Parsons et al. (2018). Forty-eight participants from the Parsons et al. (2018) study completed 3 months of the TOBY app for a prescribed 20 min per day using an iPad© provided by the researchers. All participants lived in regional areas of Australia and received minimal support from researchers due to limited resourcing in the project and to simulate ecological conditions likely experienced in regional Australia. A comprehensive description of the intervention can be found in Parsons et al.'s (2018) study. To evaluate the appropriateness of the TOBY app, a five dimension framework commonly applied in allied health and therapeutic interventions as described by Evans (2003) was used, namely: (1) the intervention addresses a health issue important to the participant; (2) involvement is a positive experience for participants; (3) the outcomes are perceived by participants as beneficial; (4) the components of the intervention are ecologically valid (logistically viable in the participants' everyday context) and (5) techniques are continued to be used once the intervention has ceased (Allan et al. 2018; Bowen et al. 2009; Cordier et al. 2016; Nastasi et al. 2000; Wilkes-Gillan et al. 2015).

To date, there has been only one paper investigating parent's experiences of using the TOBY app using thematic analysis, with none applying an established framework to investigate its appropriateness (Rogerson et al. 2018). Further, limited research has been conducted to date into the appropriateness of ICT-based interventions for children with ASD, a crucial aspect of evaluating complex psychosocial interventions (Campbell et al. 2000; Craig et al. 2008; Smith et al. 2007). Participants in the Rogerson et al. (2018) study were sampled from an effectiveness study by Whitehouse et al. (2017)—consisting of families living mostly in major cities in Australia. Participants from the Whitehouse et al. (2017) received fortnightly phone calls and completed the TOBY app for 6 months. In the context of evaluating the appropriateness of the intervention, the Rogerson et al. (2018) study did not apply a theoretical framework to anchor their analytic claims, a known limitation of thematic analysis (Braun and Clarke 2006; Rogerson et al. 2018). As a result, findings did not encompass key dimensions of appropriateness, such as the perceived importance health issue the TOBY app was addressing, the perceived benefit of the TOBY app and the continuation of the skills learnt while completing the TOBY app.

Furthermore, when compared to parents in the Rogerson et al. (2018) study, participants from this study were solely from regional areas of Australia, received minimal support from researchers, and used the TOBY app for 3 months. Moreover, the absence of a theoretical framework in the Rogerson et al. (2018) study, and different ecological factors during the intervention phase between the Whitehouse et al. (2017) and the Parsons et al. (2018) study's participants support further investigation into the appropriateness of using the TOBY app from the perspective of parents living in regional Australia in the Parsons et al. (2018) study.

Using robust qualitative research methodology anchored in a theoretical framework, this study aims to evaluate the appropriateness, a key dimension in the development and evaluation of complex interventions, of the TOBY app for families of children with ASD living in regional Australia (Campbell et al. 2007; Craig et al. 2008; Evans 2003). Further, this study aims to provide insight into the barriers and facilitators identified by parents who used the TOBY app living in regional Australia. The findings could also provide valuable insight into ICT-based interventions and better inform the development and use of other ICT-based interventions for clinicians, researchers and developers that use parent-mediated interventions to complement existing therapy services.

Methods

Research Approach

As this was an exploratory study about parents' perceptions, the study was guided by a qualitative design using the approach to thematic data analysis outlined by Braun and Clarke (2006). Thematic analysis is an accessible and flexible method that can be used to summarise key features and themes from a large body of data and offer a thorough description of the data set (Braun and Clarke 2006). Furthermore, this type of analysis is more descriptive than interpretive, focusing more on the description of the participant's experience and less on the interpretation by the researcher (Creswell 1998).

Participants

Participants were parents of a child with ASD who had participated in a three-month RCT using the TOBY app (Parsons et al. 2018). Maximum variation purposive sampling was used to recruit parents from the RCT study participants to minimise bias. Given the relative homogeneity of the parents based on gender, age range, and non-urban context, we maximised variation within the available sample by recruiting participants from three categories: low ($n = 8$), medium ($n = 8$) and high ($n = 8$) levels of recorded app use in the RCT. App use was measured using backend server data that is automatically gathered from the tablet device. Participants were ranked for use on three measures: (1) time spent using the app on the device; (2) items attempted; and (3) items completed. The rationale was to obtain a rich and overarching narrative based on information related to both the enablers and the barriers in using the intervention by gaining insights from participants with varying levels recorded use of the app. That is, exploring the different experiences from a range of participants, as opposed to making explicit and descriptive between-group comparisons. Twenty-four mothers of a child with ASD from a pool of 59 families from the RCT agreed to participate in this study. Parents were included if they had delivered the TOBY app intervention to their child throughout the intervention period of the RCT and were available to complete a telephone interview. Semi-structured interviews between 20 and 45 min in duration were conducted to explore the experience of the TOBY app. All participants were mothers, and their demographic information is summarised in Table 1.

Table 1 Participant demographics

Participant variables	(n=24)
Age (years)	
Mean (SD)	37.0 (5.05)
Gender	
Female	24 (100%)
Family structure	
Two-parent	17 (71%)
Single parent	7 (29%)
Number of children with ASD	
1	21 (88%)
2 or more	3 (12%)
Average number of children in care	
Mean (SD)	2.7 (1.06)
Mothers education	
Diploma or below	20 (83%)
Bachelor degree or above	4 (27%)
Remoteness area ^a	
Inner regional	16 (67%)
Outer regional	7 (30%)
Remote	1 (3%)
SEIFA ^b decile	
Mean (SD)	5.5 (1.98)
Child variables	
Age (months)	
Mean (SD)	60 (18.90)
Gender	
Male	18
Female	6

^aBased on the Australian standard geographical classification system (Australian Bureau of Statistics 2011). The categories include major cities, inner regional, outer regional, remote, and very remote based on a number of variables including population size and distance by road to service centres

^bSEIFA Socio-economic index for areas

Procedures

Ethical approval was obtained from the Curtin University Human Ethics Committee before commencing the individual interviews (approval number: HR 123/2014). There were no adverse events to report, and no participants withdrew from the study. Conflicts of interest were declared at the beginning of all interviews, with parents being fully informed the interviewer had no vested interest in the app. Travelling distances were prohibitive to conduct face-to-face interviews. Hence, phone interviews were used with the aim of being more convenient for participants. Interviews were conducted at a time convenient for participants, occurring between February and June 2017. Parents' experiences of the TOBY app were ascertained using a semi-structured interview, exploring the following areas:

(1) the child's experience using the app; (2) parents' experience using the app; (3) if parents perceived the TOBY app to be effective for their child; (4) if parents perceived the TOBY app to be effective for themselves; (5) the ease of use, including the planning needed to implement the suggested dosage; (6) the level of support required to use the app effectively; (7) their intended future use of the app; and (8) suggested improvements to the app (See Supplementary File 1). A combination of open and close-ended questions were used to explore themes and clarify meaning. Close-ended questions with yes/no options were followed by probing open-ended questions to fully capture the perspective or experience.

Interviews lasted between 16 and 45 min in duration, and a digital voice recorder was used to record the interviews, which were subsequently transcribed verbatim by a professional transcription service.

Data Analysis

Systematic coding and categorisation were completed using transcriptions of the in-depth interviews (Liamputtong 2013). Thematic analysis was performed identifying trends and patterns of words used, their frequency, their relationship, and the structures of discourses of communication (Braun and Clarke 2006). Six steps of data analysis were followed as described by Braun and Clarke (2006): (1) familiarising oneself with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report or article. NVivo© software was employed to manage the data by categorising and summarising data that were similar.

The semi-structured interviews were based on the literature of evaluating appropriateness for interventions for children with ASD. That is, questions sought to explore the five dimensions of the appropriateness framework, namely: (1) the intervention addresses a health issue important to the participant; (2) involvement is a positive experience for participants; (3) the outcomes are perceived by participants as beneficial; (4) the components of the intervention are ecologically valid (logistically viable in participants' everyday context); and (5) techniques are continued to be used once the intervention has ceased (Allan et al. 2018; Bowen et al. 2009; Cordier et al. 2016; Nastasi et al. 2000; Wilkes-Gillan et al. 2015).

Trustworthiness was established based on the four strategies recommended in the literature: credibility, transferability, dependability, and confirmability (Anney 2014; Krefling 1991; Shenton 2004). All interviews were conducted by the first author, an experienced occupational therapist and skilled interviewer, to enhance consistency. Throughout the data analysis, process interpretations were cross-checked over several research meetings by the

second author; an experienced qualitative researcher who had no involvement in the RCT and added a non-biased and critical layer of independence to the analysis. The development of sub-themes and themes were discussed among the entire research team at several team meetings until full agreement had been reached. A clear audit trail using thematic analysis was maintained throughout the process. Finally, transcriptions were sent back to the participants for member checking, to ensure accurate recording of their responses to add further rigour to triangulation strategies. The evaluation of the themes against the five dimensions of the appropriateness framework and their relationship strength (no support, partial support, or strong support) was discussed among all authors at several team meetings until consensus was reached. A ten-point rating scheme was also created for completion by parents to ascertain their perceptions of: (1) their skill using the

technology; (2) the child's experiences of using the TOBY app; (3) their experience of using the TOBY app; (4) benefits to the child using the TOBY app; (5) benefit to them using the TOBY app; and (6) usability of the TOBY app. These quantitative secondary data supported data collected in the interviews and triangulated themes identified (Krefting 1991).

Findings

Thematic analysis of interview data led to the development of a thematic schema (see Fig. 1). The schema visually represents the relationships between the themes. The schema consists of three levels; one core theme, two major themes, and five sub-themes. Pseudonyms for children have been used when reporting findings for confidentiality.

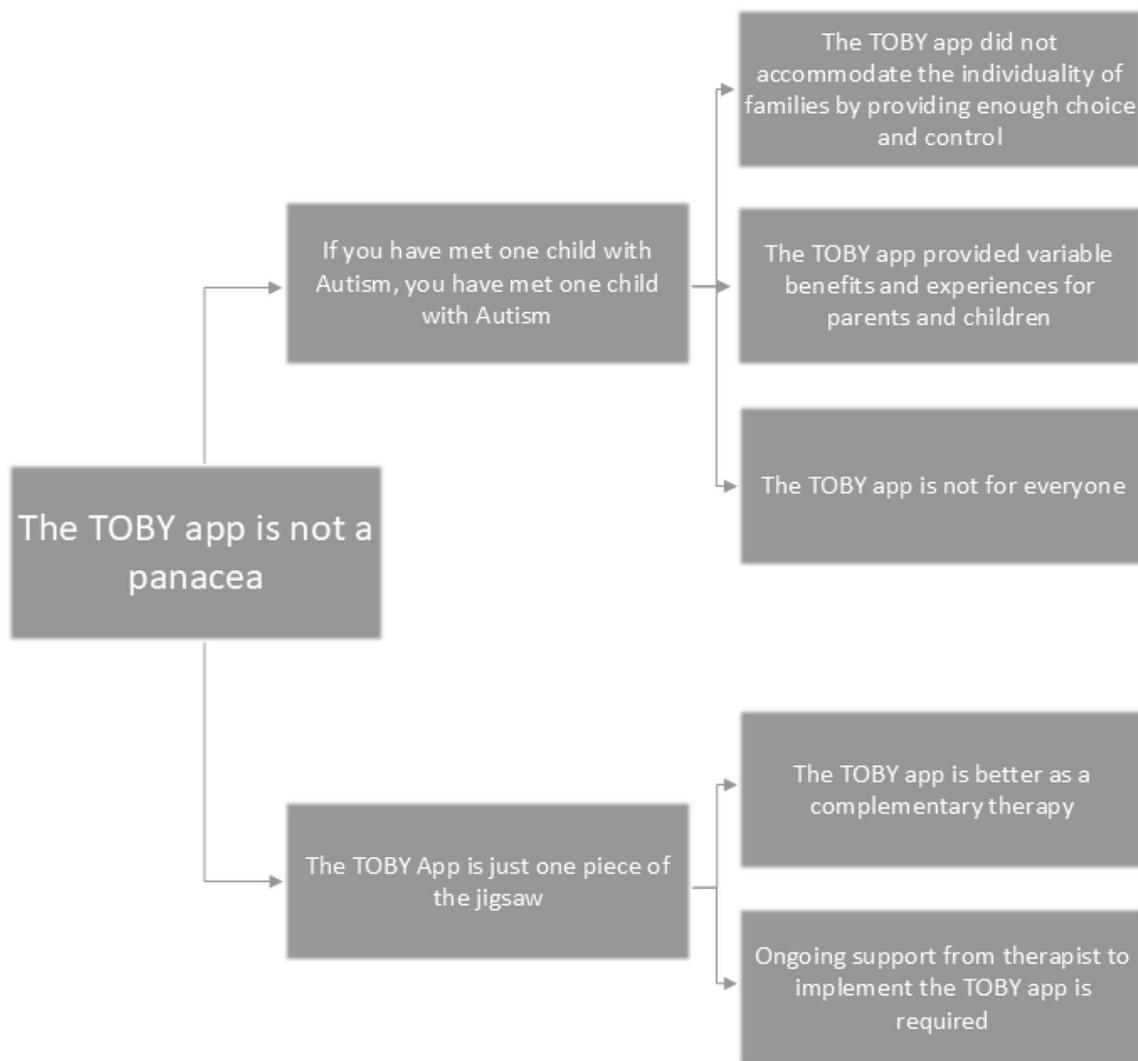


Fig. 1 Thematic schema

Core Theme: The TOBY App is Not a Panacea

Overall, parents expressed that while the TOBY app was useful as a complementary intervention, it was not going to be the solution to all of their children's challenges. This led to the development of the core theme: *The TOBY app is not a panacea*. There were both data to suggest the TOBY app was effective and beneficial to both the parent and their child, as well as, data to suggest the TOBY app was not effective or beneficial for parents and their children. That is, the data did not indicate parents conclusively perceived the intervention to be beneficial for them or their children at the group level.

Parents strongly expressed the need for additional support from therapists. Parents reported the need for support in relation to challenges associated with engaging their child with the TOBY app, and the need for strategies to address problem behaviours arising from using the TOBY app. All 24 parents indicated they would recommend the intervention to a friend, suggesting while they acknowledge the TOBY app might not be beneficial for some children, they believe it holds merit and may be beneficial for other children with ASD with differing needs or interests. Moreover, this finding suggests that parents deemed the TOBY app to address issues that were relevant and important to both them and their children. When asked if they would recommend the app to their friend, one parent's comment best summarises the parent's responses: "Well, I would just tell them [about] our experience with it [the TOBY app] and that every child is different, to definitely give it a try, and if it works for them, to continue to use it."

Parents reported a broad range of the benefits of the TOBY app, as well as some challenges they experienced while implementing the intervention. This eclectic and often conflicting data lead to the development of two sub-themes (see Fig. 1).

If You Have Met One Child with Autism, You Have Met One Child with Autism

This major theme reflects the individuality of the children who received the intervention and was continually reinforced throughout the interviews. Heterogeneity of the perceived benefits, as well as the differing experience for all participants, led to the third level of the thematic schema (see Fig. 1). The following comment from a parent best summarises this sub-theme: "Cos like I said, I did quite like it, just not for my Jack."

The TOBY App Did Not Accommodate the Individuality of Families by Providing Enough Choice and Control

Parents described the frustration of their inability to control the content which both themselves and their children were

completing on the TOBY app. Parents felt the scaffolded curriculum tree was too restrictive, thus not allowing them to choose the difficulty level of the activities their children were completing. Parents reported their experience and the benefits for the children would have been improved with more choice and control about what activities their children completed on the TOBY app. The following parent comment captures this theme:

Her receptive language is really good. So asking her to find the same or this or that or the other thing was a bit too simple for her but there was no way to 'skip' those and just go to the areas that I felt she needed I think. That was a bit of a problem for me.

Additionally, some parents wanted more choice about the pictures of everyday items used in the app to generalise skills to real-world contexts. They felt their children would have responded better if they could take pictures of the items they had in their own house, instead of generic items included in the TOBY app.

I remember grabbing something. I said, "Look, they're the same." So showing him a photo on TOBY [app] and showing him what's in front of him. I said, "Those things are the same." They look 'different', but they are just the same. Just that side of things. Like being able to put the image that the child is used to?

The TOBY App Provided Variable Benefits and Experiences for Parents and Children

Parents reported a broad range of benefits of the TOBY app; however, from the parents who suggested the TOBY app was effective, no strong consensus was evident suggesting the TOBY app was superior in the development of any particular skill. Parents reported improvements in their children across a wide variety of skill areas, such as: (1) behaviour; (2) visual-spatial skills, such as matching and visual discrimination; (3) fine motor skills; (4) daily routines, such as dressing, showering, and meal times; (5) social engagement with peers and parents; (6) joint attention; (7) cognitive tasks, such as problem-solving; (8) play; and (9) language. Additionally, parents reported the TOBY app was easy to use, with clear instructions. Some parents reported the TOBY app helped them to better understand their children's strengths and weaknesses in the skills the TOBY app was targeting, while improving their own skills in delivering EIBI to their children.

It definitely taught me about early intervention, and it taught me what James needed and didn't need. That was important. It also gave me confidence in my perception about what he could do, and I do think it was important for the parent as well as for the child.

The TOBY App is Not for Everyone

Despite a number of parents reporting the benefits of using the TOBY app, some parents stated the app provided little benefit to their children. “I don’t think there have been any huge changes over that time period. Like nothing that really ‘stood out’ to me at any rate.” One of the main issues parents reported experiencing was difficulty in engaging their children with the TOBY app. See the comment from a parent that captures this notion:

Paul’s interest was lacking in the TOBY app. Which was a surprise ‘cos looking at it with the options for fireworks and stars and all those things for the rewards that it does give and the feedback that it does give, he really had no interest.

Parents commonly stated it was challenging to find time to complete the suggested 20 min per day, especially if their children were at school or attending other therapy appointments. Additionally, in the opinion of some parents, it was difficult to keep their children interested for the recommended 20 min per day.

There’s therapy and everything else. It was just yeah, little bit out of reach. I did try. Most days we did but, yeah, and the 20 min, that’s a long time to try and get a little boy who doesn’t sit still for a second to try and sit down.

Finally, a number of parents reported problem behaviours manifested throughout the intervention period while using the TOBY app. Parents reported their children experienced issues with sleep and tantrums when the session with the TOBY app concluded and the iPad needed to be taken off them. For example, parents reported the following: “I don’t know, the thing with the app is ‘cos it’s sort of stimulates her little mind and then she can’t sleep”, “I can’t just take it off her cos that’s a meltdown”, “He’s ‘addicted’ to the iPad now” and “Well it didn’t work for us because my son gets too obsessed with technology and his behaviour and his abilities were going backwards from being on the iPad too much.”

Major Theme—The TOBY App is Just One Piece of the Jigsaw

This major theme captures the notion that the TOBY app is just one component of a broader therapy landscape. That is, parents were firm of the opinion the TOBY app should not be used in isolation and ongoing support, as well as other therapeutic interventions, are still required to address their children’s needs. This major theme derives two sub-themes (see Fig. 1).

The TOBY App is Better as a Complementary Therapy

Most parents reported that while the TOBY app was beneficial and could demonstrate utility in decreasing the frequency of therapy sessions, particularly for families who needed to travel considerable distances to services; it could not, and should not, replace face-to-face therapy.

Look, I think after having done it, I think that you can’t replace the ‘face-to-face.’ So that’s my opinion for my child. I also think that the App is very easy to understand and very easy to follow and we were successfully able to follow the instructions and do the tasks. I wasn’t successfully able to get my child to comply. I also wasn’t successfully able to figure out where we should be ‘at.’ So you could quite easily download it from the App store and use it and follow along – there’s certainly enough instructions in it. But in terms of ‘best practice’ for just the therapy, then I don’t think that should be the sole thing that you’re doing.

Parents expressed the utility of the TOBY app for its ability to increase the amount of therapy their children receive. Parents suggested that when used in conjunction with a therapist, the TOBY app can be used to reinforce therapy goals at home by allowing the child more opportunities to practice a particular skill area.

Yeah, it just gave him that little bit more time to work on those skills that he was trying to develop in therapy, it kind of worked like a follow-up. So you don’t wait a full week to then go back and practise that skill. Even though we try and do it, it’s just another backup if you like. Another way to reinforce it. The skills that he’s been learning.

Finally, parents reported that the TOBY app held potential as a tool used to receive therapy via telehealth delivery methods. Parents reported the TOBY app could assist therapists to receive objective data regarding the children’s abilities in particular skill areas, which could aid in informing the therapist in their clinical reasoning from a remote location.

It would be good for families living in a regional area that hasn’t got many services. Working with TOBY [app] and in conjunction with their therapists in another area would be really good. That would be an awesome idea. At least these therapists that aren’t actually face-to-face with them can actually access the app and see where they’re at. So when they see the parents next, they can tell them what they may need to work on sort of thing. So it just helps everybody.

Ongoing Support from Therapists to Implement the TOBY App is Required

Parents overwhelmingly reported the need for ongoing support from therapists while completing the intervention, particularly if problem behaviours associated with the ICT use emerged or the child refused to engage with the TOBY app.

You would probably need a therapist, just in terms of I suppose like ‘trouble-shooting’ like say when Amy couldn’t do something and she just refused to do it. Someone then who might have some ideas as to how to get around that possibly or if you feel like the child’s you know, not progressing and then what could you do or something along those lines

“I think conferring with the therapists and seeing that part of the app where they can see where she’s at sort of thing, and they can put their input into what areas they think need to be worked on.”

Evaluation of Themes Against an Appropriateness Framework

Overall, the parents’ evaluation of the TOBY app as an appropriate intervention was partially supported, when identified themes extracted from the interview were evaluated against the five dimensions of the appropriateness framework (see Fig. 2) (Bowen et al. 2009; Evans 2003;

Nastasi et al. 2000). Broken lines in Fig. 2 represent parents’ partial support of the intervention’s appropriateness for the corresponding dimension, whereas solid lines represent parents’ full support of intervention’s appropriateness. Collectively, parents felt the TOBY app was relevant and important to them and their children’s needs, while expressing partial support of the TOBY app as: (1) a positive experience for them and their children; (2) beneficial for them and their children; (3) a socially and ecological valid intervention; and (4) an intervention that supported change and continuation in the skills learnt.

Results from Rating Scale Data

Parents generally reported positive scores on the 10-point scale for appropriateness. See Table 2 for a full summary of the results. The TOBY app’s usability scored the highest with a mean score of 8.52 (SD 1.7). Interestingly, parents rated using the TOBY app was a better experience and more beneficial for them, compared with their children. Parents self-report of their skills in using technology was the lowest score, although this was still relatively high with a mean score of 6.91 (SD 1.76). A one-way ANOVA was conducted for between-group comparisons for low, medium and high users and no significant differences were detected for any of the items.

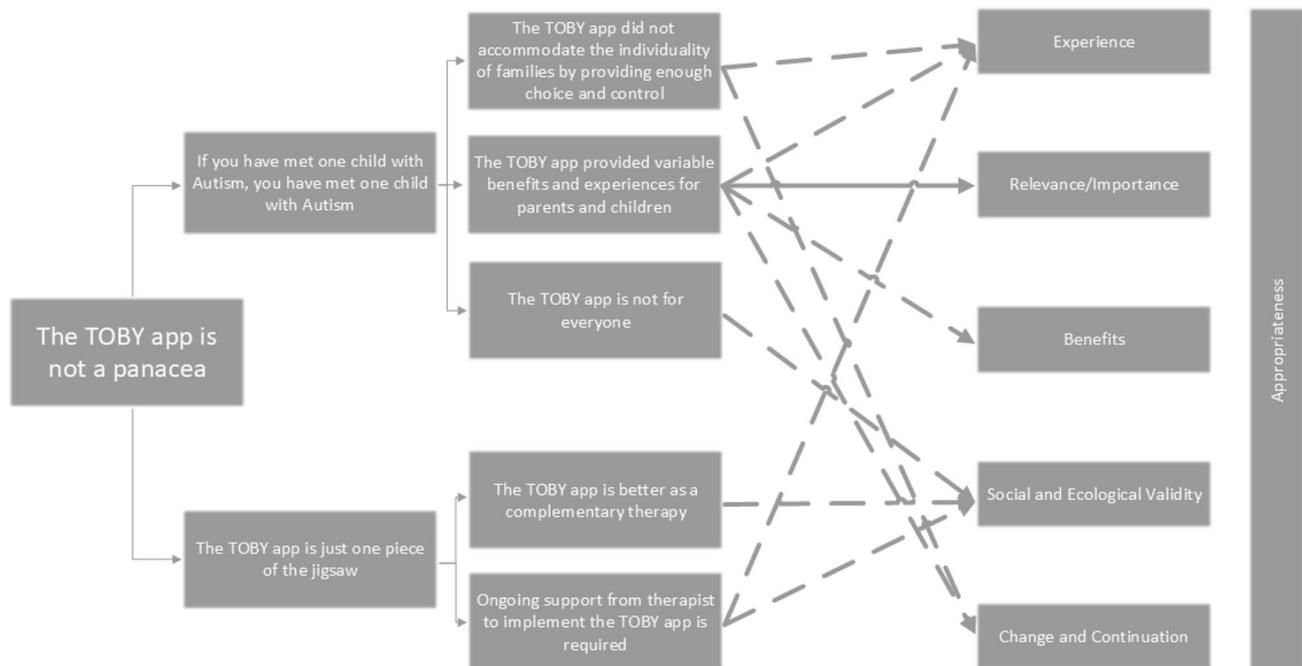


Fig. 2 Thematic schema evaluated against an intervention appropriateness framework

Table 2 Parent ratings of quantitative questions

Question	Low usage ^a	Medium usage ^a	High usage ^a	Combined ^a
Overall, how would you rate your skills with technology?	7.14 (1.07) 5–8	7.14 (2.19), 3–10	6.56 (1.76), 4–10	6.91 (1.76), 3–10
What would you give out of 10 for your child's experience of the application?	7.29 (1.80), 5–10	7.86 (1.57), 6–10	6.44 (2.60), 2–10	7.13 (2.10), 2–10
What would you give out of 10 for your experience of the application?	8.00 (2.16), 5–10	8.57 (1.27), 7–10	7.89 (1.83), 5–10	8.13 (1.74), 5–10
What would you give out of 10 for the benefits to your child in using the application?	7.43 (1.98), 5–10	9.00 (1.27) 7–10	7.11 (2.89), 2–10	7.73 (2.31), 2–10
What would you give out of 10 for benefits to you in using the application?	7.29 (2.75), 2–10	9.00 (1.41), 7–10	8.11 (1.83), 4–10	8.13 (2.07), 2–10
What would you give out of 10 for the application's usability (how easy or hard was it to use the application) with 10 being very easy and 0 being very difficult?	8.57 (1.99), 5–10	9.29 (1.25), 7–10	7.89 (1.69), 5–10	8.52 (1.70), 5–10

^aMean; (SD); range

Discussion

In this study, parents living in regional areas who completed 3 months of the intervention as part of an RCT examining the effectiveness of the TOBY app, an ICT-based intervention, were interviewed to evaluate the intervention's appropriateness (Parsons et al. 2018). To the authors' knowledge, this is the first study to apply an appropriateness framework to an ICT-based intervention for families of children with ASD. Further, this is the first study to investigate the experience of using an ICT-based intervention for families of children with ASD living in regional areas. The thematic analysis generated the core theme—the TOBY app was not a panacea for all their children's barriers. Importantly, this core theme reflects the heterogeneity in parents' perceptions in the outcomes for their child with ASD who used the intervention, not the TOBY app's failure to address all barriers in all children, which is not the TOBY app's intended function. Furthermore, collective responses from parents indicated that the TOBY app was more appropriate for some children with ASD, but less so for others. Parents suggested that the TOBY app should be just one part of the therapy landscape, and cannot and should not replace face-to-face therapy, but complement it. This finding reinforces similar findings of the seminal work by Silver and Oakes (2001).

Applying the Core Themes and to an Appropriateness Framework

Intervention as a Positive Experience, Relevance and Importance

Parents reported mixed results in their experience with the TOBY app. Most parents stated the TOBY app was straightforward to use, with clear instructions and easy navigation. These findings are consistent with previous studies

investigating the user experience for the TOBY app (Roger-son et al. 2018; Whitehouse et al. 2017). Despite this, some parents reported some issues with the TOBY app that tainted their experience: (1) it was challenging to get their children to engage with the app for 20 min per day; (2) a limited ability to choose and control the activities completed on the app; (3) the manifestation of problem behaviours in their children associated with using the TOBY app; and (4) the need for ongoing support from therapists, which they did not receive as part of this research project. Parents reported negative experiences with the TOBY app may have limited the dosage and fidelity of the intervention, thus reducing the benefits of the app. Collectively, these findings partially support the TOBY app is appropriate from a user perspective; however, more need to be done to improve this experience for both parents and children.

These findings highlight the need for developers and researchers of ICT-based interventions for children with ASD to pay particular attention to the user experience of both the parents and the children. That is, ICT-based interventions for children with ASD should be engaging, easy-to-use, responsive to children's developmental level, and include customisation options for parents to better individualise the intervention to their children's needs and intrinsic motivations (Whyte et al. 2015). The heterogeneity between children with ASD creates the need for developers to give users greater choice and control over their experiences, such as customisable pictures and activities, to improve outcomes through increased engagement, dosage and treatment fidelity. This finding builds on the work by (Allen et al. 2016) who recommend ICT-based interventions should have the ability to create and integrate customised visual inputs to improve the child's language and social skills.

Current literature supports the inclusion of gamification elements in ICT-based interventions through storylines and goal-directed learning to enhance motivation and

contextualise learning (Baranowski et al. 2008; Whyte et al. 2015). Further, by parents having increased control over their children's experience through increased customisation, the children using the intervention should have a more contextualised learning experience. An increased contextual learning experience could not only increase engagement in the child, but may also increase the likelihood of transference of learnt skills into real-life contexts; a well-known challenge in ASD interventions (Kourkoulou et al. 2012; Ramdoss et al. 2012).

Parents in the study acknowledged the relevance of the TOBY app, with all participants expressing their desire to help their children overcome their developmental challenges. Additionally, all parents interviewed would recommend the TOBY app to a friend, even if they felt it was not beneficial for their children, indicating they believe its utility and relevance for helping children with ASD. Therefore, the participants support the appropriateness of the TOBY app in relation to its relevance and importance to both them and their children.

Intervention is Beneficial

Parents reported varying levels of benefit for their children across a broad range of skill areas, indicating the TOBY app was not superior at developing any one skill over another, but did have utility in increasing the amount of EIBI their child received. However, the sub-theme '*The TOBY app is not for everyone*' suggests the TOBY app is not appropriate for every child with ASD. Parents reported the TOBY app allowed them to become better at helping their children by increasing their knowledge and skills with ASD, including ASD interventions, and by understanding their children's needs more. Specifically, parents reported an increased understanding of their children's strengths and weaknesses, while at the same time improving the EIBI skills the app was teaching them. This is a key finding in this study and is congruent with the outcomes in remotely-delivered or parent-mediated intervention effectiveness studies for families of children with ASD (Heitzman-Powell et al. 2013; Hutton and Caron 2005; Vismara et al. 2013; Wacker et al. 2013). With increased knowledge, skills, self-efficacy and understanding of their children's needs, parents are better poised to become more skilled as active agents of change in their children's development (McConachie and Diggle 2007; Solish and Perry 2008). Findings from this study suggest the TOBY app is appropriate for parents, key agents in the delivery of the TOBY app, but should be framed with consideration of the previous finding—that the TOBY app is too rigid and lacks the individualisation that face-to-face therapy can provide.

Lastly, it should be noted that the perceived benefits from parents could result from parental expectations and placebo

effects (Fageera et al. 2018; Masi et al. 2015). Moreover, given the lack of significant changes in visual motor, imitation, receptive language and social skills in the effectiveness trial, interpretation of this finding should be considered with due caution. Overall, these findings partially support the TOBY app's appropriateness as a beneficial intervention; however, it was evident that the TOBY app did not benefit all participants.

Intervention as a Social and Ecologically Valid Intervention and Change and Continuation

The core theme '*The TOBY app is just one piece of the jigsaw*' supports the partial social and ecological appropriateness of the TOBY app. For some parents, it was achievable to complete the desired 20 min of therapy once-per-day; for other parents this was not an achievable goal. Busy family lives, school commitments, other therapy appointments, and a lack of time were often cited as barriers. These findings are similar to those reported in other studies regarding the barriers to completing parent-delivered or Internet-based interventions (Mackintosh et al. 2012; Sinclair et al. 2013). Parents in this study reported that ongoing support from a therapist would be beneficial when using the TOBY app, indicating ongoing support would improve the overall appropriateness of the intervention. However, the increased support may have the unintended consequence of reducing the feasibility of the intervention. This finding builds on previous studies reporting therapist support, initial training for parents to use the intervention, and knowledge sharing increase parents' satisfaction and sense of competence in the delivery of interventions (Allan et al. 2018; Allen et al. 2016; Foster et al. 2013).

Some parents stated that the TOBY app was useful for them living in regional areas as it could help reduce, but not replace, the number of face-to-face therapy sessions required. Thus, decreasing the distance travelled to access these services and increasing the ecological appropriateness of the intervention. Service delivery models incorporating telehealth and ICT-based interventions are emerging as viable and feasible intervention delivery methods for families of children with ASD experiencing service access issues due to geographical distance (Antezana et al. 2017). The findings from this study support the potential of ICT-based interventions, including the TOBY app, for clinicians and families living regional areas in alleviating some of the considerable economic burden associated with accessing the appropriate services (Hoogsteen and Woodgate 2013; Horlin et al. 2014).

A number of parents reported continued use of the skills and strategies learnt throughout the intervention periods, while others had ceased entirely. Notably, some parents reported improvements of their children in daily living skills

that they directly attribute to using the TOBY app, such as bath and mealtime routines, achieved throughout the intervention period had been maintained up to 12 months after cessation of the TOBY app use with the ongoing use of strategies learnt. Therefore, there is partial support for the appropriateness of the TOBY app as an intervention that promotes change and the continuation of learnt skills in children with ASD and their parents.

Limitations

This study has some notable limitations. Participants in this study were recruited solely from participants in the RCT by Parsons et al. (2018). Recruiting only from this source could skew respondents to those who already perceive the relevance of the TOBY app, therefore contributing to selection bias. The level of support provided to the participants in the RCT was restricted due to available resources of the researchers and to increase the ecological validity, based on the assumption that, in real life, families can download the app and use it without any support.

In this study, all participants were mothers with only one living in a low socioeconomic area based on the SEIFA index (Pink 2011). Hence, generalisation of study findings to fathers, lower socioeconomic populations, and parents living in major cities may be limited. However, participants in this study are likely to be representative of those who are most likely to use the TOBY app and other ICT interventions, given mothers in families of a child with ASD are more likely to adopt primary caregiver roles, such as delivering home-based interventions like the TOBY app, compared to families without children with ASD (McAuliffe et al. 2017; Nealy et al. 2012)

Finally, although the primary researcher—the interviewer—declared no conflict of interest with the TOBY app at the beginning of each interview, due to resourcing issues, the primary researcher conducted 20% of the assessments in the RCT. Participants in this study could perceive a conflict of interest and tailor their responses accordingly.

Implications and Future Research

This study illustrates that ongoing support is a necessary component in the provision of ICT-based interventions for families living in regional and remote areas and should be a consideration for practitioners working with families from these areas. Future research into the role of ICT-based interventions as a complement to telehealth interventions to improve accessibility and reduce the economic impact for families who need to travel vast distances to gain access to services is warranted.

Parents expressed the need for ongoing support when using the TOBY app. Researching the experiences of the TOBY app from therapists' perspectives could provide valuable insight. Convergence of therapists' and parents' data may provide further strategies for the ongoing development and implementation to improve therapy outcomes for children with ASD using the TOBY app and other ICT-based interventions. Further investigation into the optimal level of support provided to parents implementing the TOBY app should be considered. Given the increasing demand for therapy resourcing, having increased knowledge regarding the level of support required to ensure parents can effectively deliver the intervention will improve the feasibility of ICT-based interventions. Knowing the optimal level of support to provide could also help clinicians improve the experience of the parents and benefit of the children from using the TOBY app.

Furthermore, the subtheme 'The TOBY app is not for everyone' suggesting the TOBY app is not appropriate for every child is congruent with other studies investigating predictors for symptoms change in children with ASD. That is, due to the highly heterogeneous nature of ASD, children with ASD respond very differently to the same interventions, and more research is required to ascertain "what works for whom and why" (Hudry et al. 2018; Vivanti et al. 2014). Lastly, this study used maximum variation purposive sampling that included low, medium and high users of the TOBY app to obtain a rich and overarching narrative based on information related to both the enablers and the barriers in using the intervention. This was done by gaining insights from participants with varying levels recorded use of the app to evaluate the appropriateness of the TOBY app. Between-group comparisons were not conducted to identify factors influencing dosage and adherence as the inductive nature of thematic analysis does not allow for making meaningful inferences to the broader population outside of this sample. Future research could investigate the factors (including predictor variables) that influence dosage and adherence to the TOBY app intervention using both qualitative and quantitative research methods.

Conclusion

Findings from this study partially support the appropriateness of the TOBY app for children with ASD and their parents who live in regional Australia. Thematic analysis of interviews of parents who used the TOBY app as part of an effectiveness study identified the core theme that the TOBY app is not a panacea for the challenges associated with ASD. Collectively, parents reported that the TOBY app was appropriate for some children and not others, and should be used to complement other therapies and not in

isolation. Ongoing support from therapists, increased customisation through more choice and control, and a focus on user-experience was highlighted by parents as strategies that may improve the overall appropriateness of the TOBY app.

Author Contributions DP conceived of the study, participated in its design and coordination, performed the interviews, performed the data analysis, interpreted the data and drafted the manuscript; NJW participated in the design, assisted with data analysis and interpretation of the data, and helped to draft the manuscript; SV participated in its design and interpretation of the data; HL participated in the design of the study and interpretation of the data; and RC participated in the design, assisted with interpretation of the data, and helped to draft the manuscript.

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Compliance with Ethical Standards

Conflict of interest The application described in this paper is available online through the Apple iTunes store. The authors (and funders) have no affiliation with the application or its developers and will not receive, or have previously received, any royalties from sales. The authors declare no other conflicts of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study

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