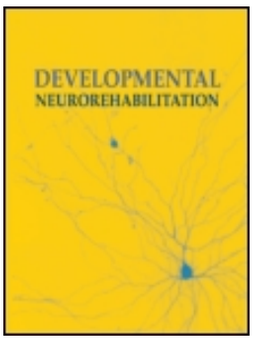

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ORIGINAL ARTICLE

TOBY play-pad application to teach children with ASD – A pilot trial

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Abstract

Purpose: To investigate use patterns and learning outcomes associated with the use of *Therapy Outcomes By You* (*TOBY*) *Playpad*, an early intervention iPad application.
Methods: Participants were 33 families with a child with an autism spectrum disorder (ASD) aged 16 years or less, and with a diagnosis of autism or pervasive developmental disorder – not otherwise specified, and no secondary diagnoses. Families were provided with TOBY and asked to use it for 4–6 weeks, without further prompting or coaching. Dependent variables included participant use patterns and initial indicators of child progress.
Results: Twenty-three participants engaged extensively with TOBY, being exposed to at least 100 complete learn units and completing between 17% and 100% of the curriculum.
Conclusions: TOBY may make a useful contribution to early intervention programming for children with ASD delivering high rates of appropriate learning opportunities. Further research evaluating the efficacy of TOBY in relation to independent indicators of functioning is warranted.

Keywords

Autism, early and intensive behavioural intervention, i-Pad, learn unit, Therapy outcomes by you

History

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Introduction

There is growing evidence that with early and intensive behavioural intervention (EIBI) sizeable gains can be made in cognitive, communication, social, academic and adaptive skills of children with an autism spectrum disorder (ASD) [1–3]. Effective interventions are characterised by a number of key ingredients including early onset of treatment, high intensity and data-based decision making. The American Academy of Pediatrics (AAP) recently released a series of recommended guidelines for nonmedical interventions for children with ASD [4]; guidelines developed by a Technical Expert Panel following a systematic review of research findings. The first conclusion of the AAP Technical Expert Panel is that: ''Individuals with ASD should receive comprehensive intervention within 60 days of identification'' [4, p.S174]. The guidelines go on to specify that such a comprehensive programme must be (i) ''... individualized to the strengths and deficits of the person with ASD, ... (ii)... must address the concerns of the family and offer opportunity for their active participation, ... and (iii)... children with ASD should be actively engaged in comprehensive intervention for a minimum of 25 h per week throughout the year'' (p.S174).

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Despite clear evidence of the benefits of EIBI for the treatment of children with ASD researchers have reported problems with the implementation of such interventions, problems with availability of suitably qualified consultants for home-based programmes and other staff to supervise and implement such programmes [5], the quality of the programs provided [6, 7], and funding more generally. In seeking feasible ways to provide effective behavioural intervention in the face of these difficulties researchers have investigated a number of alternatives including providing fewer therapy hours, and employing technology.

Eldevik et al. [8], in a two year randomised control trial (RCT), found significant gains in intellectual functioning, and both receptive and expressive communication with 12 h per week of behavioural intervention over an eclectic treatment control group but no significant differences in adaptive behaviour, socialisation or daily living skills. Peters-Scheffer et al. [9] also reported that after 8 months children in a behavioural treatment group receiving on average 6.5 h intervention per week in their RCT had significantly higher developmental ages and made more gains in adaptive skills than did a regular treatment control but no significant differences were evident on autistic symptom severity or emotional or behavioural problems present.

Though clear gains were achieved in both these lower intensity clinical trials, the gains appear not to match reported gains of more intensive (>20 h) intervention programmes [3, 10, 11]. Sufficient intensity or dosage appears to be an

important element in optimal interventions for children with ASD. Intensity of teaching, however, is not entirely captured by time engaged in instruction. Reed et al. [12], for example while finding greater gains with what they termed ''high intensity'' programmes (mean 30 h/week) relative to low intensity (mean 12 h/week) also found that within their high intensity group increased temporal input was not associated with increased gains in the children. Greer and colleagues have argued that intensity of instruction is best captured by the concept of the learn unit, which consists of an opportunity to respond, a response and feedback for each partner in a learning interaction [13]. Greer and McDonough suggest that the learn unit is the strongest predictor of effective teaching. However, elsewhere they have demonstrated that delivering correct learn units accurately and at a high rate requires considerable expertise [14]. It is not something that we can assume that parents or teachers will do readily.

A challenge for policy makers, clinicians, researchers and parents alike is to find ways to increase the intensity of the intervention programmes provided to children with ASD and their families. The use of technology in the delivery of services holds promise. Developments such as web-based behaviour capture and store technologies [15] and the emerging focus on video-based intervention procedures which capitalize on the often observed preference children with ASD show for flat screen information media/visuals [16–19] are examples of novel use of technology. Another such innovation is *TOBY* (Therapy Outcomes By You) *Playpad*, a unique early intervention iPad application for children with autism.

TOBY was designed by a team of computer scientists specialized in machine learning, working with behaviour analysts, clinical psychologists and speech therapists specialising in autism. For technical details regarding TOBY, see Venkatesh et al. [20] and Venkatesh et al. [21]. The program targets important areas of early language learning as well as skills in sensory awareness, imitation, and social interaction. In developing the program, the following system outcomes were achieved:

- A platform for flexible delivery of stimuli. The delivery of stimuli, responses, prompts and reinforcement are encapsulated in a rigorous learning framework.
- A syllabus with four main skill areas: visual and auditory understanding, receptive and expressive language, social skills including joint attention, and imitation. A flexible syllabus, responsive to the child's progress, is delivered.
- Learning trials are arranged in mixed environments, on and off the iPad, within the same learning framework.
- Prompting is increased or decreased in response to performance. Reinforcement is provided both at a trial and task level. There are strict and measureable criteria for mastery, and for progression through the syllabus,
- As well as using data to inform the immediate prompt levels provided and next steps in the curriculum, TOBY presents performance data graphically thereby facilitating data-based decision making and the tracking of progress.

TOBY adjusts stimuli, reinforcement, and prompting as a result of responses in three fundamental task types:

(1) *Solo*: Tasks in which the computer can measure the response directly, and can deliver reinforcement and prompting to the child. For example, the child is required to find a given stimulus picture from a set of pictures. The child can perform these tasks without assistance from the parent. These tasks cover a small subset of skills.
(2) *Partner*: Other tasks involve the parent. The system presents the stimuli, the parent recognises the child's response and prompts as guided by the system. The parent and child work together, the parent prompting as required and delivering reinforcement. Examples of partner tasks include expressive speech, and imitation tasks.
(3) *Natural environment task (NET)*: Computer-based activities can teach basic skills, but it is crucial that these skills can be used in other settings. To enhance generalisation NET tasks are completed off the iPad. Tasks and instructions are provided by TOBY. The instructions detail (a) how to perform the task, (b) how to prompt for and (c) reinforce correct responding. The parent performs the task with the child in play or in daily routines. Parents then provide TOBY with feedback about their child's performance which guides the system to decide progression to subsequent tasks. Each partner or solo activity has corresponding NET activities teaching the same skills away from the computer.

Solo iPad tasks consist of a series of discrete trials – a stimulus is presented by the system and a response is elicited from the child. Prompts and reinforcement follow incorrect and correct responses, respectively. Each such stimulus presentation, response and feedback (prompt or reinforcement) is effectively what Greer and others termed a ''learn unit'' [13]. This is also true for Partner iPad tasks, the difference being that here parents feed their child's response into the system, and provide prompting if required. The system gives reinforcement. TOBY comes with a built-in reward system to reinforce learning. As learners progress through tasks they collect tokens that can be spent on play activities such as painting, balloon and bubble popping, visual displays of fireworks, and access to parent-selected videos. In all cases, the system progresses to subsequent tasks based on the performance of the child thereby guiding the child systematically through the curriculum. There are between 10 and 15 specific skills in each of the four syllabus areas, with 51 skills and 326 tasks in all; 34 iPad tasks and 292 NET tasks, reflecting the focus on generalisation enhancement.

A typical day with TOBY might include 20 min of iPad time and a similar amount of time off the iPad doing TOBY-directed tasks that weave into daily routines and the child's play interests. How much time is spent in TOBY-guided activities depends on the parent and the child. Each session TOBY presents a choice of tasks drawn from the curriculum based on how the child has progressed with pre-requisite tasks. TOBY can adapt to the child's learning and developmental needs by choosing goals and adjusting the difficulty level of tasks presented. Based on TOBY's recommendations the parent can choose which tasks to complete each day and, based on the child's results, the program will generate suggestions for the following day's activities. TOBY tracks the child's progress by generating clear and easy to read reports – the parent or therapist can monitor a child's progress through the curriculum, and how much support, or prompting

is required. This helps parents, therapists and educators track the child's learning, pinpoint where and why problems might be occurring, and design strategies to address such problems.

In summary, TOBY is a program based on current best practice guidelines, which provides a comprehensive system for facilitating the delivery of intensive early intervention by parents in the home and as part of daily routines. This, together with the in-built parent training videos, might enable it to be used to bridge the oft-noted gap in service provision by enabling increased training hours for young children with ASD at home, with their parents or care givers.

In this paper, we report on a preliminary evaluation of TOBY designed to provide initial data on patterns of use and outcomes of the program under naturalistic conditions in which parents have access to the program and to the instructions provided therein regarding how to use it. The following questions are answered in this report:

Do people use TOBY?
If so, how much?
Do they use the NET tasks as well as the iPad based tasks?
Do children benefit from the use of TOBY?
Do they learn?
What evidence is there regarding the efficiency of the program in terms of the rate of instruction delivered and learning achieved?

Method

Ethics approval was granted by an Institutional Ethical Review Board prior to commencement of the study.

Participants

Participants were parents of children with autism and their children from a large urban centre in Australia. Parents were recruited through internet advertising with the understanding that they could withdraw at any time without notice. Due to the anonymous data capture processes data could not be withdrawn once the participants had uploaded it.

Recruitment specifications were that the participating child be aged 16 years or less, have a diagnosis of Autism or Pervasive Developmental Disorder – Not Otherwise Specified, and not have an intellectual disability or other developmental delay. Participants were required to have an effective non-vocal communication capacity – generally through gestures, and other physical actions (such as hand leading, bringing items), and sounds, but with some vocal capacity, typically single words or two-word phrases. The children also were required to be able to sit at a table for up to 10 min at a time and have some familiarity with a computer. Families were required to have an iPad updated to the current version of the Operating System and wireless internet connection. The explanatory statement indicated that it was anticipated that they would be able to complete activities across the week (preferably daily) over a period of 4–6 weeks. Parents were not given any further instruction or support, nor were they encouraged or directed to use TOBY throughout the trial period.

All 33 children participated in the pilot and data were collected for each participant over between 4 and 6 weeks.

Materials

An iPad for each participating child loaded with the TOBY app and connected to the internet. In addition various common household items (e.g. socks, small toys) was used by the parents in NET activities.

Data collection

All participant responses were uploaded, automatically in the case of Solo and Partner activities and manually, by the parents, for NET activities, as an integrated part of TOBY use. Dependent variables generated by TOBY algorithms were (i) participant use patterns including total time engaged in Solo, Partner and NET activities, number of sessions and of completed learn units (stimulus, response, feedback – sequences) and (ii) indicators of child progress: correct/incorrect response patterns differentiated across the four curriculum areas.

Results

Use pattern across the cohort

Data on TOBY use and response patterns by this cohort of 33 children and their parents/caregivers are presented in Table I. The data presented in the table which reflect use patterns include total time TOBY was open (hours), number of sessions, number of minutes engaged in TOBY tasks, and proportion of time in Solo, Partner and NET activities (%).

The total time the program was open during the trial period includes the time parents spent viewing tutorials and instructions. All except four participants (#12, 20, 21 and 23) spend some time engaging with TOBY at some level in on average 44 sessions (number of distinct occasions that TOBY was opened during the trial period; range 2–151). Of those participants who engaged with TOBY as evidenced by completing part of the curriculum, some did not engage in iPad tasks (participants # 5, 8, 22, 26 and 33). The remaining participants engaged in iPad tasks on average 178.5 min (range 16.85–671.11 min). In this time, these 24 participants completed on average 1129.9 learn units (range 15–4182). Overall, the data presented suggest that use patterns varied widely; only 23 of the 33 participants completed more than a hundred learn units (range 112–4182 complete learn units [CLUs] across the trial period).

Table I also presents the proportion of the TOBY curriculum (iPad and NET) each participant completed. Those 23 children who were exposed to at least 100 CLUs completed between 100% (five children) and 17% of the iPad curriculum. Fewer children engaged in the NET activities; while one completed 100% of these tasks, 19 completed less than 10% of the NET curriculum and of these 14 did not do any NET tasks.

In addition Table I presents the proportion of items participants responded to correctly while engaging with TOBY iPad tasks – a measure of the difficulty of the tasks for each participant. Scores ranged from 96% (participants 27 and 24) to 41% (participant 4).

One limitation of this study is that we do not have information regarding the entry skills of the participants. Scores of 80% correct and above are commonly considered

Table I. Participant outcome measures.

User ID	Time (h)	Sessions	Time (min) doing iPad tasks	Completed learn units	CLU/min	% Correct	% iPad curriculum completed	% NET curriculum completed	LU/1% complete
1	10.7	48	298.54	1463	4.9	85.16	100	88.2	14.63
2	12.6	74	172.87	1063	6.14	83.44	69.6	21.6	15.28
3	3.5	20	41.28	232	5.61	83.62	69.6	0	3.33
4	5.2	36	177.19	891	5.02	41.63	17.4	0	51.23
5	1.3	6		60			13	0	
6	23.1	151	490.08	2402	4.9	67.65	65.2	39.2	36.83
7	22.3	98	298.74	1824	6.1	59.92	65.2	96.1	27.96
8	1.6	5		0			4.3	0	
9	8.5	40	96.92	271	2.79	43.91	17.4	2	15.58
10	2.5	19	65.87	562	8.53	57.47	17.4	0	32.31
11	2.3	18	42.34	261	6.16	88.88	65.2	11.8	4
12				0					
13	13.4	72	518.25	4145	7.99	71.72	91.3	0	45.39
14	8.9	49	208.56	1253	6	93.37	100	52.9	12.53
15	2.8	22	108.82	888	8.16	64.52	26.1	2	34.04
16	20.2	112	671.11	4182	6.23	74.67	87	35.3	48.09
17	7.5	87	74.37	784	10.54	52.93	43.5	0	18.03
18	5	24	127.72	509	3.98	69.35	30.4	2	16.72
19	10.9	50	153.06	788	5.14	79.18	73.9	3.9	10.66
20				0					
21				0					
22	1	2		0			4.3	0	
23				0					
24	11.3	74	123.37	955	7.74	96.12	100	98	9.55
25	7.2	76	146.16	1054	7.21	88.99	100	100	10.54
26	1.8	5		51			4.3	19.6	
27	1.6	24	22.91	112	4.88	96.42	52.2	13.7	2.14
28	1.9	22	31.36	200	6.37	81.5	30.4	49	6.57
29	1.9	21	16.85	85	5.04	62.35	26.1	0	3.25
30	4.3	28	107.18	820	7.65	92.19	87	0	9.43
31	6.5	30	264.66	1751	6.61	65.27	91.3	9.8	19.17
32	8.9	43	119.11	1495	12.55	88.69	100	84.3	14.95
33	5.2	21		1			8.7	35.3	

to be indicative of mastery of a skill. It can perhaps therefore be assumed that those participants with an average rate of correct responses of 80% and over already had many of the skills in their repertoire. Future studies should assess relevant entry skills before exposure to TOBY. For the purpose of further analyses those participants with a rate of correct responses of 80% and over, and those with fewer than 100 CLUs were removed from the sample. The remaining 11 participants: # 4, 6, 7, 9, 10, 15, 16, 17, 18, 19, 31 are highlighted in Table I. The learning outcomes for these participants are summarized in the next section.

Learning outcomes for 11 participants

Data collected by TOBY which is indicative of learning outcomes is also represented in Table I. These include the number of completed learn units, completed learn units per minute, % iPad curriculum completed, % NET curriculum completed, and learn unites required to complete 1% of the curriculum.

These 11 participants experienced an average of 6.18 CLUs/min (range 2.79–10.54), at an average level of 61.5% correct (range 41.63–79.18%), completing on average 48.62% of the i-pad curriculum (range 17.4–91.3%), and 17.3% of the Net curriculum (range 0–96.1%), which on average required 28.24 CLUs to complete 1% of the curriculum (range 10.66–51.23).

The groups of learners that completed a large proportion of the i-pad curriculum (>70%) and a small proportion of the curriculum (17.4%) included both slow and fast learners as measured by number of CLUs required to complete 1% of the curriculum (ranges 10.66–48.09 and 15.58–51.23, respectively). This suggests that TOBY caters equally well to slow and fast learners.

Discussion

The results reported show that TOBY was used to some extent by the majority of families in this trial. This suggests that even without therapist support and in the absence of any kind of encouragement, parents were able to utilize this tool. Though use patterns in this study varied widely, some families engaged with TOBY extensively and to good effect.

Clearly, in order to be of benefit tools such as TOBY need to be attractive and easy to use. Reasons for non-use of this resource could include accessibility issues (instructions for parents are too complex or require too much time) or contextual issues, such as high levels of parenting stress. Parents confronting a diagnosis of autism with one of their children are often initially quite overwhelmed [22]. The cohort in this study is likely to include families in this situation. It is also possible that some of the participating families were unaware of the importance and potential benefits of EIBI. Future studies should aim to increase rates

of active engagement with the program by offering some parent education and support.

A significant limitation of this study was that no independent pre- or post-intervention measures of functioning were obtained, nor was there a control group for comparison. We are therefore, limited in the extent to which we can ascribe positive outcomes to the TOBY intervention. However, the data obtained on the completion of learn units are of interest. Research has shown that high rates of opportunities to respond are associated with better learning outcomes especially if they are accompanied by correct teacher responses or feedback. Hence, both quantity and quality of CLUs need to be considered [14]. TOBY is likely to deliver more opportunities to respond than a person in a discrete trial training program as it requires no pauses for data collection. Toby is also likely to be more reliable than even a very experienced teacher at delivering correct feedback. Finally, as TOBY makes curriculum decisions based on feedback gained in interaction with the child, a match between a child's current knowledge and the difficulty level of tasks offered by the program is assured, thereby optimizing the benefits associated with active engagement with TOBY. Future research is warranted exploring the relationship between CLUs and rate of learning for individual children. The current data suggests that those children who engaged with TOBY regularly made gains in terms of progressing through the curriculum. Most of these children engaged not only in iPAD tasks but also in NET tasks, which should facilitate maintenance and generalisation. However, without independent data on indicators of functioning we can only speculate as to the actual impact of TOBY on children's development and performance. Future studies should address these shortcomings by including pre and post intervention data on a number of indicators of functioning as well as assessing the degree of generalisation and maintenance of treatment effects. However, the preliminary indicators of learning presented here suggest that TOBY is potentially useful in contributing to the efficacious delivery of early intervention.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

References

1. Eldevik S, Hastings RP, Hughes JC, Jahr E, Eikeseth S, Cross S. Using participant data to extend the evidence base for intensive behavioral intervention for children with autism. American Journal on Intellectual and Developmental Disabilities 2010;115:381–405.
2. Peters-Scheffer N, Didden R, Korzilius H, Sturmey P. A meta-analytic study on the effectiveness of comprehensive ABA-based early intervention programs for children with autism spectrum disorders. Research in Autism Spectrum Disorders 2011;5:60–69.
3. Virués-Ortega J. Applied behavior analytic intervention for autism in early childhood: Meta-analysis, meta-regression and dose-response meta-analysis of multiple outcomes. Clinical Psychology Review 2010;30(4):387–399.
4. Maglione MA, Gans D, Das L, Timbie J, Kasari C. Nonmedical interventions for children with ASD: Recommended Guidelines and further research needs. Pediatrics 2012;130:S169–S178.
5. Johnson E, Hastings RP. Facilitating factors and barriers to the implementation of intensive home-based behavioral intervention for young children with autism. Child: Care, Health & Development 2001;28:123–129.
6. Bibby P, Eikeseth S, Martin NT, Mudford OC, Reeves D. Progress and outcomes for children with autism receiving parent-managed intensive interventions. Research in Developmental Disabilities 2002;23:81–104.
7. Jacobson JW. Early intensive behavioral intervention, Emergence of a consumer-driven service model. The Behavior Analyst 2000;23: 149–171.
8. Eldevik S, Eikeseth S, Jahr E, Smith T. Effects of low-intensity behavioral treatment for children with autism and mental retardation. Journal of Autism and Developmental Disorders 2006;36: 211–224.
9. Peters-Scheffer N, Didden R, Mulders M, Korzilius H. Low intensity behavioral treatment supplementing preschool services for young children with autism spectrum disorders and intellectual disability. Research in Developmental Disabilities 2010;31: 1678–1684.
10. McEachin JJ, Smith T, Lovaas OI. Long-term outcome for children with autism who received early intensive behavioral treatment. American Journal on Mental Retardation 1993;97:359–372.
11. Sallows GO, Graupner TD. Intensive behavioral treatment for children with autism: Four-year outcome and predictors. American Journal on Mental Retardation 2005;110:417–438.
12. Reed P, Osborne LA, Corness M. Brief report: Relative effectiveness of different home-based behavioral approaches to early teaching intervention. Journal of Autism and Developmental Disorders 2007;37:1815–1821.
13. Greer RD, McDonough SH. Is the learn unit a fundamental measure of pedagogy? Behavior Analyst 1999;22:5–16.
14. Ross DE, Singer-Dudek J, Greer DR. The teacher performance rate and accuracy scale (TPRA): Training as evaluation. Education and Training in Developmental Disabilities 2005;40(4):411–423.
15. Oberleitner R, Ball J, Naseef R, Stamm BH. Technologies to lessen the distress of autism. Journal of Aggression Maltreatment Trauma 2006;12:221–242.
16. Jowett L, Moore DW, Anderson A. Using an instructional iPad-based video prompting package to teach numeracy skills to a child with an autism spectrum disorder. Developmental Neurorehabilitation 2012;15(4):304–312.
17. Kagohara DM, Sigafoos J, Achmadi D, O'Reilly M, Lancioni G. Teaching children with autism spectrum disorders to check the spelling of words. Research in Autism Spectrum Disorders 2012; 33:1658–1669.
18. Moore DW, Anderson A, Treccase F, Deppeler J, Furlonger B, Didden R. A video-based package to teach a child with autism spectrum disorder to write her name. Journal of Developmental and Physical Disabilities 2013. doi: 10.1007/s10882-012-9325-x.
19. Shukla-Mehta S, Miller T, Callahan KJ. Evaluating the effectiveness of video instruction on social and communication skills training for children with autism spectrum disorders: A review of the literature. Focus on Autism and Other Developmental Disabilities 2010;25:23–36.
20. Venkatesh S, Greenhill S, Phung D, Adams B. Cognitive intervention in autism using multimedia stimulus. Proceedings of the 19th ACM international conference on multimedia, MM '11, New York; 2011:769–770.
21. Venkatesh S, Greenhill S, Phung D, Adams B, Duong T. Pervasive multimedia for autism intervention. Pervasive and Mobile Computing 2012; in press.
22. Karst JS, Van Hecke AV. Parent and family impact of autism spectrum disorders: A review and proposed model for intervention evaluation. Clinical Child and Family Psychology Review 2012; 15(3):247–277.