A SMARTPHONE APPLICATION DESIGNED FOR TEACHING EMERGENCY SAFETY SKILLS TO CHILDREN

Joelene Huber[1,2,3,4,5], Scott So[7], Thivia Jegathesan[1], Sarah Davis[1], Michelle Goodman[1], Niraj Mistry[1,4], Elizabeth Young[1,3,4], Douglas Campbell[1,4], Herbert Joseph Bonifacio[1,4,6] and Alex Mihailidis[5,7]

[1]St.Michael's Hospital, Department of Pediatrics, Toronto, Canada

[2]The Hospital for Sick Children, Division of Neurology, Toronto, Canada

[3]Division of Developmental Pediatrics, [4]Department of Pediatrics, University of Toronto, Canada

[5]Department of Rehabilitation Sciences, University of Toronto, Toronto, Canada

[6]The Hospital for Sick Children, Divisions of Emergency Medicine and Adolescent Medicine,

Toronto, Canada

[7]Toronto Rehabilitation Institute, University Health Network, Toronto, Canada

Abstract

Background. *Training children to recognize emergencies and dial 911 can save lives. Children as young as four years are able recognize emergencies and call 911. Mobile phones are rapidly replacing landline phones. With this advancing technology, many children do not know how to dial 911 on a mobile phone. Applied Behaviour Analysis (ABA) principles, through simulated practice (behaviour skills training), has been shown to be an effective way to teach emergency skills.* ***Objectives.*** *The goal of this project was to design a smartphone application (app) that utilized ABA training strategies with simulated practice that could be used to teach children to recognize emergencies, dial 911 and respond to a dispatcher on a mobile phone.* ***Methods.*** *An inter-disciplinary design team of experts from developmental pediatric medicine, behaviour therapy, simulation, biomedical engineering, and mobile app design developed a smartphone app that utilizes the principles of ABA and simulation training techniques, including video modelling, simulated practice with prompts for errorless learning opportunities, feedback (positive reinforcement), systematic fading of prompts and advancing of skill level as target skills are achieved.* ***Results.*** *The app includes a modelling video, simulated training to recognize emergency situations, and teaching to dial 911. The app includes verbal, visual, and textual prompts, gradual fading of prompts when accuracy is achieved and gaming-style feedback. The advanced levels also provide practice responding to a simulated 911 dispatcher, with voice recognition capabilities, including identifying type of emergency, name, location, description of event and answering a simulated 911 dispatcher's questions. Accuracy, number of attempts and level of achievement data are collected.* ***Conclusion.*** *We developed an operational prototype of a smartphone app designed to teach children to recognize emergencies, respond, dial 911 and communicate to a dispatcher on a mobile phone utilizing ABA principles and simulated practice. Studies are planned to evaluate the app effectiveness and utility for emergency skills training in children.*

Keywords

mobile health, smartphone application, applied behaviour analysis, simulation, autism spectrum disorders

Background

Training children to recognize emergencies and dial 911 can save lives. Children as young as three to four years of age are able to recognize emergencies and dial 911(1-4). Many children, however, do not know how to respond, if faced with an emergency situation, placing them at a significant safety risk.

Personal mobile smartphones are rapidly replacing landline phone use. Children today are "digital natives," growing up in a world surrounded by technology and not knowing a world without it. Children have been reported to be the largest new user group of mobile technology, suggesting a transition from landline phone use to mobile phones (5). In addition multiple reports have suggested greater learning opportunities in children with mobile technology education than traditional education (6). However due to the complexity of mobile devices, compared to landline phones, children may not know

how to access the emergency call function or dial 911 on a mobile device. Also, 911 dispatchers are often unable to verify a location from a mobile phone call and would therefore require a child's report of their address and/or location (7).

The Canadian government Health-Emergency preparedness recommendations advise preparing children for emergencies and training emergency recognition and response skills, such as dialing 911, through *simulated practice* (8). Simulated practice has been shown to be an effective education strategy for building competence in emergency skills (9-11). *Applied Behaviour Analysis (*ABA) principles through *simulated practice* (also known as behaviour skills training) is an effective way to teach children *new* skills (12,13). ABA teaching principles (*modeling, rehearsal, performance* and *feedback*), with simulated practice, utilize prompts and positive reinforcement while systematically fading prompts, based on the child's individual success, as target skills are achieved (12, 13).

Currently, in many Canadian cities, emergency education for children is primarily offered through regional police services school visits. Most of these education programs involve didactic teaching about emergencies, but typically do not involve a hands-on or simulated practice component (9). Emergency education strategies without simulated practice and without teaching the use of current technology may not adequately meet the modern learning needs of children.

Objective

The objective of this study was to design a smartphone mobile application using ABA principles and simulated practice to teach children to identify an emergency, call 911 and report their name, emergency and location.

Methods

Step 1: Establishing the need for emergency training with mobile technology for all children

Safety in emergency situations is a major concern for all children. With the progression toward the broader use of mobile technology, children require specialized and practical mobile technology training, as opposed to traditional teaching. A mobile technology emergency skills training program should aim to be inclusive of children of varying abilities and include those with developmental disorders. Children with developmental disorders are reported to be more at risk to injury from an emergency than typically developing children (14). Many children with Autism Spectrum Disorders (ASD) demonstrate a lack of safety awareness (14), placing them at an even greater risk of danger than their peers in emergency situations. Even though a greater risk of

harm among children with ASD exists, due to limited safety skills, teaching of safety skills in educational settings with children with ASD is often limited. Children with developmental disorders, such as ASD, are a special population that mobile health technology for emergency skills should aim to create suitable training strategies for (14,15).

Given the limited opportunities for children with and without ASD to practice emergency skills with current mobile technology, and the unique training needs of children with ASD, an inclusive emergency mobile training program with simulated practice was identified as a need for preparing children for emergencies.

Step 2: Assembling a multi-disciplinary team for a sociotechnical approach

There is an inter-relatedness between society and technology, and it is important to take a sociotechnical design approach to improve emergency safety skills among children using mobile technology (16). A multi-disciplinary team of experts was assembled from developmental pediatric medicine, behaviour therapy, simulation, biomedical engineering, and smartphone application design to work collaboratively on the sociotechnical design of a mobile smartphone app that could provide training of emergency safety skills to children using mobile technology. A multi-disciplinary, sociotechnical approach that utilizes the collaborative expertise of scientific and technology experts was used (16).

Step 3: Designing an emergency skills protocol

Experts from developmental pediatric medicine, behaviour therapy, and simulation developed an overall vision for a smartphone app with an emergency skills training protocol that would best meet the needs of children, including children with ASD, for responding to an emergency using a mobile phone.

It was determined that an emergency skills simulation program (behavioural skills training), utilizing ABA principles would be the most effective framework for teaching children with varying levels of skill and ability to call 911. ABA techniques have been shown to be effective for teaching new skills to typically developing children and to children with developmental disorders, such as children with ASD (15). A behaviour skills training framework uses four components; 1) modelling 2) rehearsal, 3) feedback, and 4) performance to teach and help children learn new skills, preferably in the context of simulation (12). In consultation with emergency personnel, an emergency skills simulation protocol, based on these ABA training principles, was developed, as described below.

Modelling is a process by which an individual demonstrates the correct behaviour or skill for the learner (12). As a type of prompt, the goal of modelling

is to help the child imitate the model. A model can be another individual, or a symbolic object, like a video or audio recording (12). A modelling video was planned, with a child peer demonstrating the correct response to an emergency, dialling 911, and answering dispatcher questions.

The *rehearsal* process is important, as it allows the learner multiple practice opportunities while acquiring the target skills. The application design plan included multiple opportunities to witness a simulated emergency or non-emergency (video), recognize the emergencies, respond and navigate a mobile smartphone screen, dial 911 on the key pad, and answer a simulated dispatcher's questions (with voice recognition capabilities).

Feedback is critical to shape behaviour and skill learning toward reaching the specified training goals. Feedback helps the learner to effectively identify areas of strength and success as well as areas that need improvement. The app design plan incorporated multiple prompting techniques (i.e. verbal, visual, and textual) with systematic fading of these prompts (i.e., advancing the level of difficulty) based on the learners performance, allowing for errorless learning opportunities.

Step 4: Operationalizing the emergency skills training protocol: Translation to technology

Experts in developmental pediatric medicine, behaviour therapy and simulation worked alongside experts in biomedical engineering and mobile application development to operationalize the emergency skills protocol design to a mobile platform using "Android Studio".

Results

Overview of Mobile Application

A multi-disciplinary team described above developed a fully operational smartphone app prototype called "911 Sim Kids"© with ABA teaching techniques, designed to teach children to recognize emergencies and call 911 on a mobile phone through simulated practice. The 911 Sim Kids© app includes a demonstration video (modelling), followed by a behaviour training module (rehearsal, performance, prompts and feedback) with simulated practice to recognize emergency situations and to learn how to respond by dialing 911 on a mobile phone.

The 911 Sim Kids© app training includes verbal, visual, and textual prompts, gradual fading of prompts when accuracy is achieved, and gaming-style feedback. The advanced levels of the app also provide simulated practice responding to a 911 dispatcher with voice recognition capabilities, including identifying type of emergency (i.e., fire, ambulance or police), name,

location, describing the emergency, and answering a simulated dispatcher's questions. Accuracy, level of achievement and number of attempts are stored as data.

Mobile application features

A simulated mobile phone screen and number pad were created. Using a standard protocol provided by 911 emergency personnel, a simulated 911 call was created using voice commands. Each question was followed by visual, verbal and textual prompts in order to teach the correct response.

> "9-1-1 emergency do you need fire, ambulance or police"?
> "What is your name"?
> "What is your address"?
> "What is your emergency"?
> "Stay calm and with [the person] help is on the way"!

Figure 1: Simulated 911 dispatcher script

A *settings section* was designed to enable parents/caregivers to personalize the app prior to use. This includes entering the child's name and address that is then stored in existing speech recognition library for the app to recognize when the child responds to the first two questions asked by the dispatcher

Information from the settings section is used within the *rehearsal* session to 1) personalize the scenario; 2) provide personalized information for the child through the verbal, visual, and textual prompts;,and 3) determine accuracy of the child's responses.

After entering the personal settings information, a video of a child peer modelling the correct response to an emergency, dialling 911, and answering dispatcher questions is shown in order to demonstrate the target training goal.

Following the modeling phase, the *rehearsal phase* of the 911 Sim Kids© app involves a *simulated practice* which includes nine video vignettes of emergency and non-emergency situations. During the *rehearsal phase,* one of nine videos is randomly presented. Six of the videos are emergency situations requiring a child to dial 911 and three of the videos are non-emergency situations. The purpose of this feature is to teach children to discriminate emergency situations from non-emergency situations. The child is trained to respond, navigate a mobile phone, and dial 911 through prompts that are gradually faded with successful learning.

After dialing 911, a simulated dispatcher provides audio prompts through a series of emergency questions simulating the standard 911-dispatcher protocol (Figure 1). Speech recognition (from an Android device's built-in speech recognition library) is used to identify the child's response. The app analyzes the success of the child's response by matching it to a list

of key words that were entered into the library as potential correct responses.

Gamification within the app allocates points for each step a child completes successfully. Consistent with ABA training principles, once a child successfully completes 80% of the steps involved, they move onto the next training level, which includes less prompts. The most advanced level of the app requires the child to distinguish emergencies from non-emergencies, recognize to need to respond in an emergency, navigate a mobile phone, dial 911 and report their name, location and the emergency without any visual, verbal, or textual prompts.

A success tracker allows for progress to be tracked and saved to a report card, including: 1) frequency and dates of use; 2) child's success rate; and 3) time it takes to complete a session.

Conclusion

To our knowledge, the 911 Sim Kids© app is the first smartphone application of its kind designed to teach children emergency mobile phone safety skills using ABA principles and simulation. This mobile application will undergo several levels of testing to ensure validity, utility and effectiveness.

Future Directions

A blinded randomized controlled trial is planned to evaluate the effecitveness and utility of 911 Sim Kids© app as an emergency skills training tool compared to traditional education of emergency skills, with typically developing children. Once effectiveness and utility in of the app with typically developing children has been established a randomized controlled trial with children with ASD will be conducted to determine its effectiveness and utilitiy in this special population. After determining effectiveness and utility, dissemination of the app is planned in order to improve emergency safety skills among children.

Acknowledgement

References

1.   Brown J. Oshawa boy hailed as hero after saving dad with 911 call Toronto: The Star; 2014 [cited 2014 September 22nd]. Available from: http://www.thestar.com/news/gta/2014/03/31/oshawa_boy_hailed_as_hero_after_saving_dad_with_911_call.html.
2.   Criger E. Girl, 9, calls 911 after father collapses Toronto: City News Toronto; 2013 [cited 2014 September 22nd]. Available from: http://www.citynews.ca/2013/03/14/girl-9-calls-911-after-father-collapses/.
3.   Franklin J. Young boy credited for saving mom's life Toronto: Toronto Sun; 2011 [updated 2011; cited 2014 September 22nd]. Available from: http://www.torontosun.com/2011/12/30/young-boy-credited-for-saving-moms-life.
4.   Hempstead D. Ottawa boy makes the right call, savers brother's life
 Ottawa: Ottawa Sun; 2013 [cited 2014 September 22nd]. Available from: http://www.ottawasun.com/2013/05/04/ottawa-boy-makes-the-right-all-saves-brothers-life.
5.   Druin A. Mobile technology for children [electronic book] : designing for interaction and learning / edited by Allison Druin: Amsterdam ; Morgan Kaufmann Publishers/Elsevier, 2009.; 2009.
6.   Nouri J, Cerratto-Pargman T, Rossitto C, Ramberg R. Learning with our without mobile devices? A comparison of traditional school field trips and inquiry based mobile learning activities. Research & Practice in Technology Enhanced Learning. 2014;9(2):241-62.
7.   Police T. Communications Services: Explore E9-1-1 Toronto: Toronto Police Services; 2014 [cited 2014 September 22nd]. Available from: http://www.torontopolice.on.ca/communications/e911-faq.php#q04.
8.   Canada Go. Using 9-1-1 2012 [cited 2014 September 9th]. Available from: http://healthycanadians.gc.ca/health-sante/emergency-prepare-urgence/using-911-utiliser-eng.php.
9.   Police YR. Community Safety Village 2014. Available from: http://yrp.ca/csv.aspx
10.   Coles CD, Strickland DC, Padgett L, Bellmoff L. Games that "Work": Using Computer Games to Teach Alcohol-Affected Children about Fire and Street Safety. Research in Developmental Disabilities: A Multidisciplinary Journal. 2007;28(5):518-30.
11.   Trepagnier CY, Olsen DE, Boteler L, Bell CA. Virtual Conversation Partner for Adults with Autism. CyberPsychology, Behaviour & Social Networking. 2011;14(1/2):21-7.
12.   Kilroe H, Murphy C, Barnes-Holmes D, Barnes-Holmes Y. Using the T-IRAP interactive computer program and applied behaviour analysis to teach relational responding in children with autism. Behaviour al Development Bulletin. 2014;19(2):60-80.
13.   Schwebel DC, McClure LA, Severson J. Teaching children to cross streets safely: A randomized, controlled trial. Health Psychology. 2014;33(7):628-38.
14.   Bruce B, Kirkland S, Waschbusch D. The relationship between childhood behaviour disorders and unintentional injury events. Paediatrics \& child health. 2007;12(9):749.
15.   Speaks A. Autism Safety Project: Autism Speaks Inc; 2014 [cited October 1st 2014]. Available from: http://www.autismspeaks.org/family-services/autism-safety-project/safety-resources.
16.   Bikson TK, Eveland JD. Groupware implementation: reinvention in the sociotechnical frame. Proceedings of the 1996 ACM conference on Computer supported cooperative work; Boston, Massachusetts, USA. 240355: ACM; 1996. p. 428-

Joelene Huber, M.Sc., Ph.D., M.D., FRCPC
Department of Pediatrics
St. Michael's Hospital
Toronto, Ontario, Canada
E-mail: huberjo@smh.a