Hearing a Circle: An Exploratory Study of Accessible Sonification for Young Children with Blindness and Low Vision

PHIA DAMSMA

1Sonokids Australia

November 20, 2023

Abstract

This paper describes a qualitative study of educational outcomes for 0–8-year-old children with blindness and low vision (BLV) who are learning sonification concepts. Children with BLV experience barriers to accessing education and careers in Science, Technology, Engineering and Mathematics (STEM), fields which traditionally rely heavily on visual representation of information. There is growing awareness of the potential of sonification, a technology to represent data and information in non-speech audio, to improve education access. While early learning of assistive technology skills is deemed essential for equity of access to education across the curriculum, children are generally not introduced to the concept of sonification at school until at academic level in secondary or tertiary education. Little is known about how young children with BLV engage with this promising technology. Phase 1 of the project consisted of the development of ‘CosmoBally on Sonoplanet’, an accessible, educational game application for iPads and Android tablets. In phase 2, an online qualitative survey collected formal responses from users of this app to Likert scale and open-ended questions. The majority of the 17 respondents were (specialist) educators, and five of the respondents identified as having BLV. The survey investigated respondents’ perceptions of the capabilities of young children with BLV in using basic sonification in ‘CosmoBally on Sonoplanet’ to identify shapes - including a circle-, orientate in a digital grid and create drawings on a touch screen. Results suggest that young children with BLV can learn sonification skills and that they additionally build relevant non-sonification skills during this learning process. This paper aims to provide a first insight into best practice around early learning of sonification as a potential tool for increased access and inclusion of children with BLV to STEM subjects in school.
Hearing a Circle: An Exploratory Study of Accessible Sonification for Young Children with Blindness and Low Vision

Abstract
This paper describes a qualitative study of educational outcomes for 0–8-year-old children with blindness and low vision (BLV) who are learning sonification concepts. Children with BLV experience barriers to accessing education and careers in Science, Technology, Engineering and Mathematics (STEM), fields which traditionally rely heavily on visual representation of information. There is growing awareness of the potential of sonification, a technology to represent data and information in non-speech audio, to improve education access. While early learning of assistive technology skills is deemed essential for equity of access to education across the curriculum, children are generally not introduced to the concept of sonification at school until at academic level in secondary or tertiary education. Little is known about how young children with BLV engage with this promising technology. Phase 1 of the project consisted of the development of ‘CosmoBally on Sonoplanet’, an accessible, educational game application for iPads and Android tablets. In phase 2, an online qualitative survey collected formal responses from users of this app to Likert scale and open-ended questions. The majority of the 17 respondents were (specialist) educators, and five of the respondents identified as having BLV. The survey investigated respondents’ perceptions of the capabilities of young children with BLV in using basic sonification in ‘CosmoBally on Sonoplanet’ to identify shapes - including a circle-, orientate in a digital grid and create drawings on a touch screen. Results suggest that young children with BLV can learn sonification skills and that they additionally build relevant non-sonification skills during this learning process. This paper aims to provide a first insight into best practice around early learning of sonification as a potential tool for increased access and inclusion of children with BLV to STEM subjects in school.
What is Sonification

Several alternative definitions exist for sonification (United Nations Office of Outer Space Affairs [UNOOSA], 2023), but within the context of this project sonification is defined as a technology to represent data or information in non-speech audio. From a young age we are all introduced to visualisation of data by way of colour, shape, bar charts, graphs, etc. But data can also be represented in sound. Specifics of sound, such as timbre, tone, volume and pitch, can be used to represent characteristics of data or information. Sonification is not new. The Geiger Counter, developed in 1908, is an example, where the measured level of invisible radiation is indicated by the frequency of the clicking sound. Listening to data can be a valid mainstream method for data analysis as an alternative or complement to visualisation (Foran, 2022; UNOOSA, 2023). Sonification is on the crossroads of science, technology and the arts and has a general appeal. In space sciences, where outer space telescopes capture digital data outside the spectrum the human eye can detect, data sonification is often used for public outreach and education (Zanella et al., 2022). The United States’ National Aeronautics and Space Administration successfully attracts new audiences through the creation of musical sonifications of outer space phenomena (Arcand, 2022; Powell, 2023), and a multisensory planetarium show with sonification successfully engages sighted and vision impaired audiences alike (Harrison et al., 2022).

Relevance of sonification for access to science, technology, engineering and mathematics (STEM)

Scientific Research and Careers

In the last decade or so there has been an increasing awareness of the potential of sonification, as a standalone tool or combined with other sensory modes, to increase access to scientific data for people
with blindness and low vision (BLV) (Misdariis et al., 2023; Walker, 2019; Zanella et al., 2022). Recently, UNOOSA has been formally advocating to mainstream sonification as an opportunity to enhance access for people with BLV to education and careers in space science. UNOOSA has called upon government and industry to fund research and development of sonification (UNOOSA, 2023). Diaz Merced is one of a number of accomplished scientists who are blind and use cutting-edge sonification tools for astronomy research. She advocates for accessibility through sonification (Diaz Merced, 2022). Data sonification is applied to increase inclusion in oceanographic research (Bower et al., 2021). Furthermore, the Data Sonification Archive, which has been established to curate the ever-growing number of sonification projects, includes 19 projects tagged for accessibility (Data Sonification Archive).

**STEM Education**

Research has identified several factors that impact on the way children with BLV experience STEM learning in the classroom (Fanshawe, 2022). One of the biggest barriers to accessing STEM is the heavy reliance in these fields of study on data visualisation. Data visualisation includes maths graphs, bar charts, diagrams, images, and animations in textbooks and other teaching resources. While ongoing technological development may help to resolve certain accessibility issues, the search for a method that enables children with BLV to independently access original, visual data without the need for traditional alternative formats such as raised line images and tactile graphs, is highly relevant. Due to its inherent auditory character, sonification rather than visualisation as a method to represent mathematical information and scientific data can reduce access barriers arising from visual content presented in a non-accessible format. The reduction of access barriers provides opportunities for inclusive and equitable
access to learning for children with BLV. The ability to access information independently is important in ensuring they can function at the same level as their peers within the school (McLinden, 2016).

**Sonification in Education of Children with BLV**

An essential area of learning for children with BLV to ensure their appropriate and equitable education is the teaching of methods they can use to access information as independently as possible, including in non-visual ways (Hewett et al., 2022). Sonification may be such a method. Research literature suggests that early learning of fundamental, generic sonification skills may help prepare young children with BLV for future use of sophisticated sonification tools for access to the curriculum and learning, including scientific exploration and analysis (Zanella et al., 2022). Currently however, if children with BLV get introduced to the concept of sonification at school, this is generally not until at academic level in secondary or tertiary education and limited to bespoke auditory graphing software for access to maps or mathematics. According to anecdotal evidence around the use of sonification tools such as the Desmos scientific calculator (“Desmos”), SAS Accelerator software (“SAS Graphics Accelerator”), and SenseMath app (“SenseMath”) and research around ‘GNIE’ (Tomlinson et al., 2016) sonification can be successfully applied as an alternative mode of access to visual content for children with BLV. Furthermore, researchers propose that attentive listening skills and sonification should be taught to all children in the mainstream education curriculum (Cooke, 2022; Diaz Merced, 2022; Scaletti, 2017). However, little is known about the ability of young children (0-8 years of age) with BLV to listen to, analyse and interpret sonification in an effective way.
Project Rationale and Design

As described above, while sonification is accepted by researchers as a potential tool to decrease access barriers to STEM for people with BLV, children with BLV are commonly not introduced to this technology before high school, and then mostly in the specific context of mathematical graphing. The central aim of this project is to examine whether young children with BLV (0-8 years) can develop skills to explore and interact with generic sonification, and if any non-sonification skills relevant to children’s learning can be identified that may result from this process. The project’s secondary aim is to inform best practice around early introduction to sonification, for increased access and inclusion of children with BLV to STEM.

The project consisted of two phases. In phase 1 an innovative educational application for mobile touch devices was specifically designed from the ground up to offer young children with BLV (0-8 years) an opportunity to freely explore and interact with generic sonification concepts. No other such sonification project has previously been developed for this specific target group. The resulting app, ‘CosmoBally on Sonoplanet’, was released in March 2022 for use on iPads and Android tablets. Globally the free app has 50 K current downloads. In phase 2 of the project an online qualitative survey was used to capture observations, perceptions, and opinions of anonymous users of the ‘CosmoBally on Sonoplanet app’ around young children’s interaction with the app and the sonification concepts it offers. The project is supported by a dedicated website [sonoplanet.com].
Phase 1 - Design Considerations for educational app development

The design specifications of ‘CosmoBally on Sonoplanet’ are based on the proven design of the ‘Ballyland’ suite of accessible, educational game apps for iPad and Android touch tablets that support development of digital skills by children and young people with BLV (“Ballyland”). Throughout the research and design process of this app consultation took place with young children with BLV, parents and caregivers, assistive technology professionals, Specialist Teachers (Vision Impairment) and other stakeholders. Special ‘Ballyland’ design features that are applied in ‘CosmoBally on Sonoplanet’ are listed below.

Gamification

Unlike formal sonification tools designed to support increased access to a particular subject, such as mathematics, ‘CosmoBally on Sonoplanet’ applies gamification to make the novel sonification learning experience attractive for young users. To cater for children with varying levels of ability and personal interests, four audio games were developed within the one app. Please refer to Appendix 1 for the specifics of each of the games, such as gameplay, storytelling and learning goals. Each game presents a novel sonification concept and a different style of gameplay (quiz, creative, storytelling, action). While aiming to make each game as user friendly as possible, the level of difficulty of each game as perceived by the users was unknown. Therefore, the games can be played in random order. Sonification is used in order to identify shapes, trace a line, orientate in a digital grid and create drawings on the touch screen of the iPad or Android touch tablet. All games are set against the backdrop of the alien environment on
Sonoplanet, an imaginary planet discovered by Ballyland astronaut CosmoBally, where everything and everybody is sonified. CosmoBally is the children’s guide on Sonoplanet. The Space theme was used because sonification is applied to space science data analysis, and because space exploration and alien live is an appealing topic for young children.

Accessibility

The ‘CosmoBally on Sonoplanet’ app is designed to take advantage of well-established accessibility features and concepts that are embedded in mainstream mobile touch tablets, such as an iPad. The interaction with the games and navigation of the accessible app menus require the use of identical finger gestures on the touch screen to those users with BLV apply to navigate any digital app on a mobile touch device, including a smart phone, when the built-in screen reader is active - VoiceOver on iOS or TalkBack on Android. Children may already be familiar with the device and its accessibility navigation, sounds, and concepts, and this may lower the barrier for them to tackle the novel content matter. Like all ‘Ballyland’ apps, the ‘CosmoBally on Sonoplanet’ app is self-voicing and the electronic speech of a screen reader is not required.

The access needs of children who are sighted, are blind, or have low vision were considered in the app design. The power of sonification for accessibility may be enhanced when supported through multi-sensory modalities such as haptics, touch (Bonne et al, 2018) and visualisation (Harrison et al., 2022). However, visual and animated images may distract those with (low) vision from the need to focus on listening to derive essential information from non-speech audio - even as CosmoBally instructs children to “Open your ears!”. While optional provision of tactile resources is recommended, in order to test
children’s ability to analyse information through listening to sonification, the games in the app are by default set to be played through sound only. Adjustable Settings still offer the option to display sonified shapes on the touch screen.

Sonification

There are currently no standards to ensure that developers apply consistent methods to map data to sound in sonification projects or tools. The algorithm for any sonification depends on the data, situation, user, project purpose, and technical interface that is used. In view of the young age of the target user group, the sonification in ‘CosmoBally on Sonoplanet’ is kept very basic and is designed to be easily understood and learnt very quickly. Headphones are not required to analyse the sonification. This is in contrast to other sonification tools or applications that may use stereo or surround audio effects. Two young people with BLV provided essential feedback during beta testing through so-called ‘TestFlights’ of the app on iOS. Further testing through an online Quiz with 29 adult conference delegates, including 7 people with BLV, resulted in the ‘Sonokids method of sonification’ that is applied in ‘CosmoBally on Sonoplanet’. Full details of the technical and sound specifications are described elsewhere (Damsma et al., 2023). Only two variables are used: pitch - the higher a data point is located, the higher the pitch of the tone - and a ‘rhythm’ of a double tone, indicating a point on a line. The tempo of the double tone increases to the right on a line and decreases to the left. So-called ‘overtones’ are used to provide additional information, such as a ‘ding’ sound which indicates that a ‘turn’ is imminent in a sonified rectangle. The use of the word ‘turn’ - rather than, for instance, ‘corner’ - was inspired by Millar’s study of how children who are blind represent objects in drawings: After exploring the four sides of a rope
presented in a square shape, an eight-year-old girl reportedly drew a long line and noted “the rope is a long shape. It has some turns” (Millar, in Kennedy, 1993, p. 124). It is noteworthy that the Sonokids method of sonification provides directional and spatial information: the listener can analyse the direction in which a shape is being drawn, or identify a specific location in a digital grid.

**Instructional Design**

As a design principle, Ballyland apps allow for step-by-step learning. In the case of ‘CosmoBally on Sonoplanet’ consultation took place with experts from the field of Early Childhood Education (Vision Impairment) and Orientation & Mobility (O&M) to determine the most suitable vocabulary to support gradual understanding of directional and spatial concepts. This consultation resulted in the use of the terms ‘side-to-side’, and ‘up and down’ to describe the sonification of lines and shapes at the most basic level. Perceived as more difficult were ‘left to right’, and ‘right to left’, ‘bottom to top’, and ‘top to bottom’. Deemed still more advanced are ‘vertical’ and ‘horizontal’. By default, the terminology used to describe the shapes in Game 1 gradually transitions from what is perceived to be basic to advanced. However, adjustable settings were implemented to allow for individual children’s level of development and understanding. In a similar fashion the Settings in Game 4, which uses a digital game grid, allow for the spoken feedback to be adjusted to support learning of ‘spatial terms’ (e.g. ‘top right corner’) or ‘grid-terms’ (rows and columns).
Phase 2 - Qualitative User Survey

The following paragraphs describe the survey design and distribution and provides information about the respondents and their responses to the survey.

Survey Design and Distribution

The ‘CosmoBally on Sonoplanet’ app did not collect interaction data or analytical data from users, because of privacy concerns around such embedded software. Data was solely collected through a qualitative online survey which could be completed via a link from the Sonoplanet website in the period from March 2022 to February 2023. The survey was not actively distributed to users of the app, as they remain unknown. Instead, respondents were recruited indirectly: an open call to participate in the online survey was circulated via news lists and social media within the specialist education (Vision Impairment) and accessible sonification fields and publicised in the app itself. Survey respondents voluntarily and anonymously opted in to complete the survey. The only requirement for participation was to have played at least one game of the app. Respondents in the survey were invited to complete the survey on behalf of themselves or on behalf of a child. There was no financial compensation for respondents’ contribution.

Limited demographic information was collected about each respondent: profession or interest, and whether they identified as having blindness and low vision. A multiple-choice question ascertained whether respondents had actively used the app – which of the 4 games they or their student(s) played. One respondent (#18) was excluded from the results, having indicated not to have played any of the games in the app due to a technical problem. Ten Likert scale and open-ended questions collected
qualitative data about the survey respondents’ experiences using the ‘CosmoBally on Sonoplanet’ app, and their perceived effects of interaction with sonification on children. The survey used a 5-point ordinal scale for respondents to rate the degree to which they agreed or disagreed with a statement. These Statements were designed to elicit responses that could give an impression of the way in which young children may be able use sonification and of potential learning outcomes of such interaction.

Survey Respondents

Although the survey was open to everyone, all respondents indicated a link to blindness and low vision education or accessibility. Five of them identified as having blindness and low vision. Table 1 provides an overview of respondents’ roles.

<table>
<thead>
<tr>
<th>Role of Respondent</th>
<th>Number</th>
<th>Identifying as with BLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent of child with BLV</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Student, 7-10 years</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Student, 15-18 years</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Specialist Teachers VI</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Other Professional Practioners</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Interested in Accessible Games</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Survey Responses

The educational game app ‘CosmoBally on Sonoplanet’ aimed to enable free exploration of sonification concepts by children with BLV. Feedback from the 17 surveyed respondents suggest that this aim was achieved: all survey respondents agreed that ‘the app makes it possible to explore sonification’.

Working with the app also resulted in increased awareness of respondents about sonification and its accessibility benefits. There was a consensus among respondents that ‘the app helps to raise interest in
sonification’ and that ‘the app shows that people who are blind or have low vision can use sonification to access information generally represented in a visual format’ - 12 respondents agreed strongly with this statement.

The following quote may illustrate both these aspects:

“I think this app is wonderful. I will be using it with my students to build their awareness and confidence in sonification, and there is so much other learning also”. Qualified Teacher Vision Impairment.

Further survey results, including the suitability for the intended user group of young children with BLV (0-8 years), are presented and discussed by identified themes and connections between them.

*Sonification Games in ‘CosmoBally on Sonoplanet’*

Only respondents who had played at least one game of the educational app ‘CosmoBally on Sonoplanet’ were accepted in the survey results. Eight respondents indicated to have played all four games of the app. Although this was not the central aim of the survey, some information was captured about the experience of respondents with the novel sonification concepts in the games. There was no immediate correlation found between the two equally favorite games and the game that was perceived as the easiest, as shown in Table 2.
Table 2. Overview of respondents’ perceptions about the four sonification games in ‘CosmoBally on Sonoplanet’, presented in order of the games in the menu of the app

<table>
<thead>
<tr>
<th>Game</th>
<th>Number of respondents who played this game</th>
<th>Favorite Game</th>
<th>Perceived as easiest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1, Hearing Shapes</td>
<td>6</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Game 2, Explore with the Scooper</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Game 3, Sonified Drawing</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Game 4, Finding the Saliens</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>All Games</td>
<td>8</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Recommended age to start using the educational app ‘CosmoBally on Sonoplanet’

The app description in the AppStore/Google Play Store or on the Sonoplanet website did not include a recommended minimum age to use the app. However, as described, young children with BLV (0-years) were the target group for the project. Respondents were asked to indicate from what age they would recommend children’s use of the app, based on their experience. This was an open-ended question. One respondent did not provide an answer, resulting in a total of 16 responses (Figure 1). While very divergent, they do suggest that young children (0-8 years) are able to effectively use sonification.
Importantly, respondents volunteered to suggest that a child’s developmental skills should be considered in deciding the best time to work with the app. This can be illustrated by the following comments:

“It depends on the maturity of a child. If they’re willing to learn” (Professional Practitioner)

“As long as the individual is mature enough to follow basic instructions” (Specialist Teacher VI)

“I think it will be depending on the development level of the student” (Specialist Teacher VI)

Perceived learning outcomes from children’s engagement with sonification through the app

The project’s secondary aim was to identify potential valuable additional learning outcomes for young children through their interaction with sonification. Respondents unanimously agreed - 14 of them
strongly - that ‘the app supports development of attentive listening skills’. The next statement in the survey was that ‘Attentive listening and sonification training can lead to measurable improvements in students’ language and mathematical skills’. Interestingly, 16 out of the 17 respondents agreed with this statement - 11 strongly.

Respondents were then asked to review six potential learning outcomes and vote for what they perceived as the most important learning outcome from interaction with the app. Table 3 presents the results in order of votes.

Table 3. Most important learning outcome of the app as perceived by survey respondents

<table>
<thead>
<tr>
<th>Perceived learning outcomes</th>
<th>Number of votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills to analyse and interpret sounds</td>
<td>8</td>
</tr>
<tr>
<td>Learning directional concepts</td>
<td>3</td>
</tr>
<tr>
<td>Awareness that sonification is accessible</td>
<td>2</td>
</tr>
<tr>
<td>Improved fine motor skills</td>
<td>2</td>
</tr>
<tr>
<td>Awareness that sonification is fun</td>
<td></td>
</tr>
<tr>
<td>Learning shapes</td>
<td></td>
</tr>
<tr>
<td>All of the above</td>
<td>2</td>
</tr>
</tbody>
</table>

Game 3 in ‘CosmoBally on Sonoplanet’ is called Sonified Drawing. It is designed for children to actively engage with sonification through physical interaction: Dragging a finger over the touch screen produces a sonified line. Motor input is directly correlated with the audio feedback received from the sonification. It is proposed that this type of physical interaction with sonification can lead to a better understanding of this technology (Supper, 2015). It is in this context that one of the respondents, an Occupational Therapist who indicated that she completed the survey on behalf of a child with BLV (7-10 years), suggested another learning outcome from the sonification in the app:
“... has a poor body scheme awareness and attention problems. Listening and recognizing the direction of the sound is very hard for him, takes more time to train this. The drawing exercise was perfect for him because of the combination of moving himself with the finger and hearing the sound. Auditory-motor coordination?”

Discussion and Limitations

This section will reflect on the most relevant results from the survey in relation to the project goals. Some limitations of the project will be outlined.

Young children can learn to interpret and interact with sonification

The recommended age for using the app, as perceived by respondents, ranged from 2 to 8 years - and ‘all ages’. This aligns with the project’s target age group (0-8 years). That opinions were divided may be a result of individual children’s abilities and/or teachers’ personal experience and expectations. Furthermore, respondents suggest that children’s cognitive abilities need to be considered as well as their age to assess when they should start using the sonification app. If this is the case, the learning process of sonification skills may be described as ‘emergent sonification literacy’, in line with the notion of ‘emergent Braille literacy’ and research around the learning process of Computational Thinking, where skills do not readily appear at a specific age (Dietz et al, 2019).
Children develop relevant non-sonification skills through interaction with sonification

Future research is needed to confirm respondents’ opinion that listening to, interacting with, and analysing sonification supports the development of a range of non-sonification skills that are relevant to all children. ‘Skills to analyse and interpret sounds’ topped the list of most important learning outcomes of the app as perceived by respondents, followed by ‘Learning directional concepts’. Listening skills are particularly important for children with BLV: for Orientation & Mobility as well as for the effective use of auditory assistive technologies such as screen reading software. However, attentive listening skills are relevant to learning for all children (Caspersz, 2015). In the context of speech development, (second) language education (Vandergrift, 2004), following verbal instructions, and music lessons, attentive listening skills are considered essential for success. Similarly, an understanding of directional concepts and orientation and mapping skills are fundamental to mathematics. This may have led the wide majority of respondents to agree that attentive listening and sonification training can lead to measurable improvements in children’s language and mathematical skills. Finally, listening is per definition a sequential, more dynamic process than visual observation, and this may impact on the way we perceive data. Scaletti argues that “the first generation of students to learn mathematics and science through interactive sonification and animated graphs is going to be more likely to conceive of the universe as dynamic processes rather than as static snapshots of that process” (Scaletti, 2017). Research shows that children develop a range of important skills through Computational Thinking (Dietz et al, 2019; Wing 2006). Introducing children to data sonification in preschool may prove to result in the development of equally significant skills. Whether early introduction prepares children for future use of advanced sonification tools requires further study.
Limitations

Not all respondents accessed all four games so varying degrees of experience in using the app may have impacted the survey responses. The relatively small scale of this qualitative study means caution should be taken to generalise findings and conclusions.

Conclusions and Future Work

In Stage 1 of the project an accessible, educational game app, called ‘CosmoBally on Sonoplanet’ was designed and developed to establish the potential feasibility of early introduction of young children with BLV (0-8 years) to sonification, a technology to represent data or information in non-speech audio that may support equity of access to education for children with BLV.

In stage 2 the project successfully provided a first insight into the ability of young children with BLV (0-8 years) to interact with sonification, through the lens of 17 respondents to an anonymous, qualitative, online survey. Survey results suggest that the development of fundamental, generic sonification skills is possible from a very young age, and that this may positively impact the development of a range of relevant non-sonification learning outcomes: some with particular importance for children with BLV – such as listening skills and mental mapping for Orientation and Mobility – but most regarded as pertinent to the education of all young children. The survey results appear to justify the term ‘emergent sonification literacy’ to describe the learning process and suggest that this process can start at any age. The ability to analyse sonified data may not per definition depend on age, but also on children’s cognitive abilities. The survey results support literature findings that sonification can be an alternative or
complementary mode of access to information for people with BLV and suggest this may also apply to young children with BLV (0-8 years).

The ‘CosmoBally on Sonoplanet’ app and project findings may contribute to a wider acceptance and early introduction of data sonification in mainstream early childhood education. This would facilitate a more equitable access for children with blindness and low vision to STEM education and careers.

Acknowledgements

I would like to acknowledge the important input of parents, children, and young people - specifically Morgan Tyrrell and Oliver Fanshawe - and the many colleagues from the field into the early design stages of the educational game app ‘CosmoBally on Sonoplanet’. Sincere thanks go to all survey respondents who volunteered their time and expertise to provide the feedback that made this project possible. Finally, I acknowledge the important contribution of John Norgaard and Craig Cashmore to the design, development, and programming of ‘CosmoBally on Sonoplanet’ for Sonokids.

Funding

This project was made possible through a Members’ Project grant from South Pacific Educators in Vision Impairment (SPEVI Inc).
Disclosure

The researcher is a member of the Sonokids team that designed and developed the Ballyland suite of educational software and game apps, including ‘CosmoBally on Sonoplanet’.

References


Ballyland. https://www.sonokids.org


Data Sonification Archive. https://sonification.design/

Desmos. https://www.desmos.com


Appendix 1: Games in the ‘CosmoBally on Sonoplanet’ app

- Game 1 (Hearing shapes) is a Quiz designed to introduce children to Sonokids’ method of sonification (how is the data mapped to sound), and for them to analyse sonified shapes, such as lines, rectangles and circles, at the bottom of a crater on Sonoplanet. A minimum score of correct answers in part one - comparing shapes - is required to progress to the second part of the Quiz - identifying shapes.

- Game 2 (Explore with the Scooper) requires a more complex use of sonification than Game 1 as there are sounds of objects to analyse as well as the shape. It is designed to explore how sonification can be used to orientate on the screen, to learn to recognise a pattern or trend, to identify an anomaly in that pattern, and to trace a rectangle-shaped ‘track’ based on listening to the sonified feedback from finger movements on the screen.

- Game 3 (Sonified Drawing) is designed as a Sonification Makerspace for creative purposes. Directly interacting with the sonification may improve understanding of this technology (Supper, 2015). By dragging one finger over the screen, children can actively create sonified lines and shapes. They can also ‘freeze’ the image and trace and listen to their sonified drawing. By default, line drawings are displayed in yellow on black, but this can be adjusted.

- Game 4 (Finding the Saliens) implements sonification of directional sound indicators, a novel concept. The game uses a game grid of 2 x 2 in Level 1, 3 x 2 in Level 2, and 3 x 3 in Level 3 and 4. The aim is to locate ‘Saliens’ (resident aliens) in the grid (symbolising a rocky part of Sonoplanet where it is pitch dark) by analysing and combining the information from sets of two sonifications: the first representing the Salien’s position in the horizontal plane, and the second its vertical position in the grid. The short response time requires quick analysis and spatial
orientation. A minimum score is needed to progress through the levels of the game. The game instructions recommend teachers to provide a tactile grid to support children with BLV to mentally map the digital game grid.