

SLEEP THROUGH SURVEYED: USAGE AND EFFICACY OF STREAMED SOUNDSCAPES CREATED TO HELP INFANTS SLEEP

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ABSTRACT

This paper reports results of a survey that was conducted to assess the use and efficacy of soundscapes composed for an DAB+ radio station and on demand audio App ‘ABC-Kids listen’ provided by the Australian Broadcasting Corporation (ABC). The soundscapes were a series of previously composed pieces titled *Sleep Through*. 21 people who had listened to one or more of the compositions completed the survey as part of a qualitative study of how music can aid sleep. Results suggested very high overall efficacy, but also revealed applications to situations that did not involve aiding the parents and/or their infants to sleep. These included using *Sleep Through* for pleasure, and for breast feeding. Open-ended responses to the survey were organized into themes labelled: Relaxation (the most prevalent theme), Associations (often linked to the title and environments portrayed in the soundscape), Distraction (strongly related to Relaxation), and Auditory Masking. The theme labelled Habit (using *Sleep Through* to develop healthy sleeping habits) was also considered, but exhibited too great an overlap with other themes. The themes were strongly connected with those found in the literature investigating the use of music for sleep by adults, and also supported the approach of the composer. The study was conducted in collaboration with the composer, with his intentions and responses to the study forming an integral part of the research.

1. INTRODUCTION

The creative process of composition can be a one-directional process, where a composer is charged with both creation and evaluation of the creative work [1]. This responsibility means that feedback from audience, critics and other assessors can be seen as a final judgement on a piece. However, another approach is to collaborate with empirical researchers experienced in designing studies concerned with aesthetic perception. For example, the American composer Roger Reynolds collaborated with several researchers investigating the perception of his composition

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The Angel of Death, producing among other things a special issue in the journal *Music Perception* [2, 3]. Several innovative developments in such projects see productive collaboration between creative and empirical researchers. It is in this rather novel tradition that we report a study on a series of compositions by an Australian composer (author AH) that was released to a global audience via Australia’s national broadcaster and provider of online services, the Australian Broadcasting Corporation (ABC).

This paper reports the background to the piece, and the details and results of a survey completed by users of the ABC Kids listen App. The present investigation particularly focuses on an important issue in health and wellbeing, the matter of getting a ‘good night of sleep’, quality sleep having important health ramifications for both adults [4] and infants [5]. Furthermore, the ABC had a target audience for this project of an important but rarely considered demographic – young children and their carers –and the challenges of getting such a family unit to *Sleep Through* the night, using specially created soundscapes. The use of soundscapes to aid sleep is not new [6], but the close collaboration between music psychology and composer promises new insights. The paper commences with the composer’s perspective of the compositions, followed by a survey gathering usage and efficacy information from an online audience. The paper then concludes by reconciling the findings of the survey with the composer’s perspectives.

2. COMPOSER PERSPECTIVE

From its inception, the ABC Kids Listen service adopted a child-centered approach, focusing content directly to the young listener without commercial interruption. When commissioned to provide music to support this audience, the consideration was one of how to use broadcast audio to co-create, with the intended listeners, the experience of an acoustic space that was conducive to and supportive of listening, both prior to and during sleep.

In the span of 3 years, approaches evolved over the three iterations of the projects; however, four foundational approaches remained important throughout: (a) Auditory Masking, (b) Relaxation through Entrainment (c) Acoustic space and Incorporation, and (d) Association and Familiarity.

Auditory masking was important to exclude sudden unwanted intrusions that may impact sleep [7]. White noise

is particularly efficacious for this, and although used in maternity wards for this reason, it was deemed unsuitable for broadcast to a wider public and potentially disruptive for co-listening with adult carers. Instead, field recordings using naturally occurring noise (such as waterfalls, streams and wind) were adopted, to align with hypothesised listener expectations for relaxing acoustic environments. These were often accompanied with stacked harmonics produced by synthesis and reflectionless reverberation to further fill the frequency spectrum.

To support a drift into sleep, each of the pieces followed a philosophy of repetition with variation, with the intention of producing a sound event that evokes the experience of ‘everyday’—as opposed to ‘musical’—listening [8], to facilitate the experience of inhabiting a conducive acoustic space. The pieces unfolded gradually, with a foundation of simple, repetitive and slow-moving harmonic structures. Complex melodies were avoided, and expectations of rapid change were minimized. However, random seeding and generative algorithms were used to produce intricate movements in the smaller details throughout the earlier stages of each piece, in order to give active attention to something to latch onto. This gradually shifted into a simpler sustained structure towards the middle of the work and returned (to a lesser extent) towards the end, to avoid disruption if the piece was played in a recurring loop.

Drawing inspiration from Erik Satie’s project of *musique d’ameublement* [9], these pieces aimed to augment acoustic space by making it more comfortable for the activities of the listeners. However, given the centrality of early childhood development in ABC Kids listen, the long-form broadcast (or on-demand) without interruption also provided an opportunity to introduce the young listener to complex natural soundscapes and textural variation. These were included, working with the hypothesis that—particularly in hypnagogic states—exposure to these soundscapes may enrich early relationship to sound [10].

In the title for each piece, the short accompanying text on the website (written by the composer) and the sounds used, these pieces drew on ecological (relationship between humans and the environment) rather than cultural associations (human interactions), with spoken framing and associations with music found in waking life deliberately avoided. This was based on the intention that these pieces could be inhabited as unique acoustic spaces associated with sleep and relaxation. Some pieces (particularly ‘Home’) used aesthetic choices based on an understanding of the acoustics of pre-birth experience, in order to encourage associations with safety and closeness.

Of course, the intentions of the composer become largely irrelevant once the works are disseminated, unless there is a reciprocal loop between composer and listener as co-creators in the production of the listening experience. Susini, Houix and Misdariis [11] propose a relationship between sound creation and research in auditory perception wherein sound design is informed by perception research through a 3-step iterative process of analysing, creating and testing. This occurs through the co-contribution of stakeholders: ‘researchers’, ‘composers’ and ‘users’. The current study is useful insofar as it serves to explore these

compositional premises through a survey into audience reception. By doing so, it opens the ongoing development of the *Sleep Through* series into a wider conversation between stakeholders.

3. METHOD

A qualitative survey was applied to explore how *Sleep Through* was used, and to gather information about its efficacy from the child’s parents and/or caregivers.

3.1 Survey design

An online survey using Qualtrics (www.qualtrics.com) was developed to collect data for this research. There were 8 questions in total, with the first 3 being open-ended questions as to why participants choose to listen *Sleep Through* music, and were subjected to thematic analysis. Questions 4 to 7 investigated what makes these nature-based soundscapes effective or otherwise in supporting sleep. The wording of the questions are shown in Table 1:

	Question text / response options
Q1 Open-ended question	Under what circumstances are you or your child listening?
Q2 Open-ended question	What are your aims in listening to <i>Sleep Through</i> , and what works and what doesn’t work for you or your child?
Q3 Open-ended question	Which compositions in particular did you use/listen to the most and why?
Q4 Multiple choice	What musical aspect did you think was effective listening to the <i>Sleep Through</i> compositions for you or your child? <ul style="list-style-type: none"> • Use of low-pitched sounds. • Use of high-pitched sounds. • Use of white noise. • Use of nature sounds. • Use of regular beating/pulsing. • Use of irregular beating/pulsing. [see Figure 2 for answer options.]
Q5 Rating Scale	How often have you or your child listened to or used <i>Sleep Through</i> ?
Q6 Rating Scale	On average, for how long do you or your child listen to <i>Sleep Through</i> compositions?
Q7 Rating Scale	How effective were the compositions to you or your child? Please select the best answer possible.
Q8 Open-ended question	If you would like to add any further information, please do so here.

Table 1. Survey question response types and wording

3.2 Stimuli (*Sleep Through*)

As indicated in section 2, *Sleep Through* is a program on *ABC Kids Listen* (<https://www.abc.net.au/kidslisten/>) that is designed to help infants *Sleep Through* the night. At the time of the study, there were 18 different soundscapes, all of which were composed by author AH.

The *Sleep Through* soundscape tracks are laid out in blocks, with an image and a short description shown corresponding to the title of the soundscape track (see Figure 1). Participants chose their soundscapes, and streamed or download the composition in their own time.

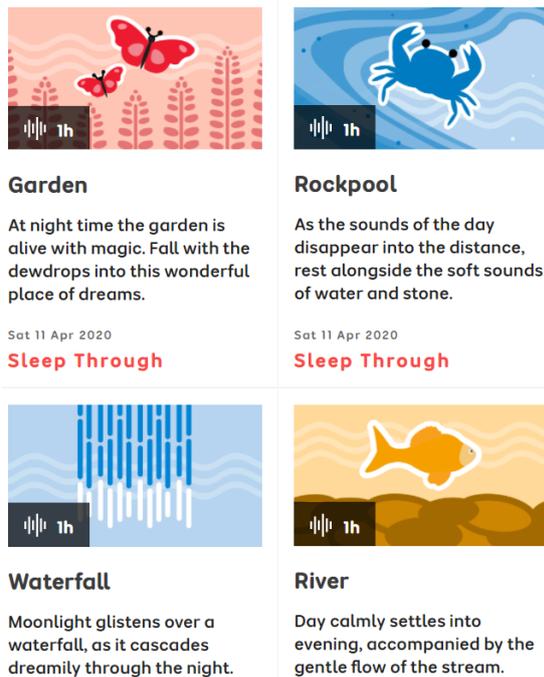


Figure 1. Hulbert’s (2020) *Sleep Through* soundscape layout in: <https://www.abc.net.au/kidslisten/sleep-through/>. Note that the list shown in the Figure is a sample of the available soundscapes. See Figure 4 for a longer listing of the soundscape titles.

3.3 Participants and Procedure

Participants were assumed to have listened to the ABC Kids listen *Sleep Through* soundscapes prior to taking the survey. A survey link was distributed through social media; gaining attention from the ABC Kids followers (either for the child or their care-givers). Participants were able to listen to the stimuli for as long as they wanted. Furthermore, participants needed to provide consent for their participation in the survey and those wanting to discontinue had the right to withdraw at any time. After two months of gathering participants, the survey was brought to a halt. Forty-four participants commenced the survey, with 21 participants completing the entire survey. The analysis of results examines completed responses only.

4. SURVEY RESULTS AND DISCUSSION

4.1 General Usage and Effectiveness of *Sleep Through*

76% of the participants used *Sleep Through* more than 8 times, with 52% of those using it for more than an hour and/or on repeat. All participants gave one of the two highest ratings regarding the effectiveness of *Sleep Through* (Question 7): 60% found *Sleep Through* to be quite effective and 40% of people found *Sleep Through* to be very effective. In terms of the effectiveness of previously investigated musical characteristics regarding to Question 4, [12-14] Figure 2 shows the graph of the results. Here participants most frequently reported low-pitched and nature sounds as effective characteristics of *Sleep Through*, with high pitched and irregular beats least effective. This is consistent with the analysis of music characteristics used to aid sleep by young adults [15] and is discussed further in section 4.2.5.

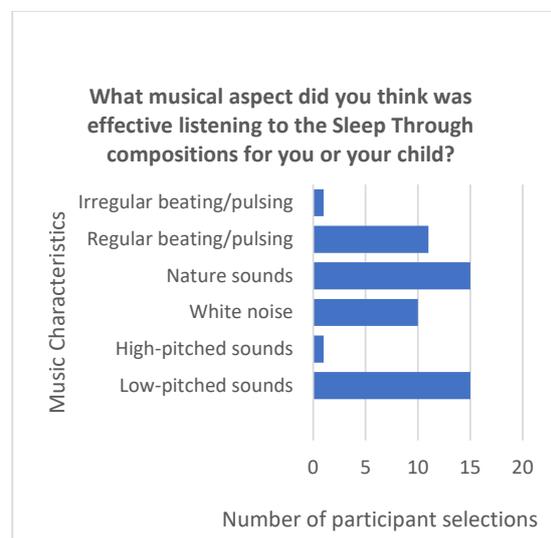


Figure 2. Distribution of answers to Question 4. What musical aspect did you think was effective listening to the *Sleep Through* compositions for you or your child?

4.2 Themes

NVivo, a qualitative data analysis software was used to aid with the organization of a thematic analysis of participant responses taken from the Qualtrics survey in categorizing certain key words or synonyms to appropriate themes. Several ways of organising the data according to theme groups were considered, and were presented as theme maps. We discuss the two most convincing theme maps. Themes were identified using a directed content analysis approach [16].

Several themes identified were based on research by Dickson and Schubert [7], Mazzarolo [17] and Trahan, et al. [18] on why music was effective in assisting sleep. Dickson and Schubert [7] found that relaxation, distraction, entrainment, masking, enjoyment and expectations were important themes. Their findings sifted through 101

publications in relation to music and sleep via online database searches and searching references. Mazzarolo [17] expanded Rogers [19] research, and noted that *Sleep Through* was based on predetermined principles (see section 2). Similarly, Trahan, et al. [18] grouped their findings using 4 main, overlapping themes: Distract, Provide, Habit and State. By applying the amalgamated themes to the survey data and then refining, the following themes were identified: Relaxation, Association, Distraction and Auditory Masking is shown in Figure 3. The possible addition of the theme Habit was also discussed (see section 4.2.3). These themes help to understand the different ways in which the compositions benefit the listener.

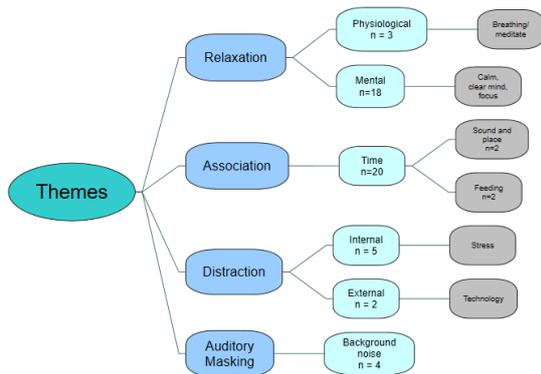


Figure 3. Theme map from the *Sleep Through* survey. The first branch of categories shows the main uses of *Sleep Through*. The second branch of categories are subthemes and the third branch are prominent responses from the sub-themes identified in the survey. ‘n’ is the number of participants whose responses could be coded into the sub-theme. The sum of n is greater than the total N (= 21) because responses from a participant could be coded into more than one theme.

4.2.1 Relaxation

Participants responded to the slow, ambient sounds of the *Sleep Through* playlist as a major source of relaxation. Relaxation refers to the tension released from the body (physiologically) and mind (mentally) to minimise and combat stress and anxiety [18]. Overall, out of 21 participants who indicated terms such as ‘relax’ or ‘calm’, 18 of them were closely linked to a mental state of mind. Examples included “it helps me relax into sleep especially after a hectic day” (P15) (P = participant code), “to calm down and clear my head (P13)” and “I find it makes me feel a lot calmer and sleepier” (P39). This theme is therefore related to the distraction theme we discuss below. 20% of these participants used music for sleep in connection with the physical process of deep breathing whilst the remaining participants used music for clearing and slowing the mind before bed-time.

The physiological process of deep breathing can be relaxing because relaxed breathing patterns calms the autonomic nervous system [20]. Nanthakwang, et al. [21] investigated deep breathing exercises and body scan meditation combined with sedative music, finding improvement

in sleep quality of adults when sedative music was playing. This is in line with the present study where three participants reported effects that were linked to physiological aspects of relaxation. P2 stated, “The rising and falling of the sound is good to regulate my breathing” and P5 revealed that “Tools such as the ABC Listen app have helped us build their skills in body awareness, step by step relaxation, and deep breathing” (Author note: The ABC Listen app can also be accessed via the Kids listen content). Additionally, P10 used *Sleep Through* for their children to “meditate before bed to get them falling asleep quicker”.

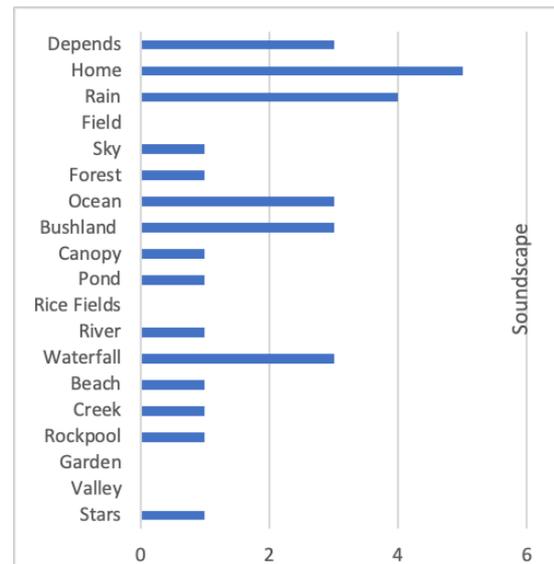


Figure 4. Frequency of selection of preferred *Sleep Through* soundscapes listened to before or whilst in bed. Note that the ‘Depends’ option reflects participants who selected more than one *Sleep Through* soundscape.

4.2.2 Association

Association refers to a mental connection between concepts, mental states or events, that usually stems from specific experiences [22]. We ascertained the significance of association from responses to Question 3 where participants chose their favourite soundscapes along with the reason for its choice. Figure 4 shows that the majority favoured the soundscape named ‘Home’ and the reasons for liking this soundscape were based on the composition itself and the description provided in the stimuli. The description of the soundscape reads “Warmth, love and peace fill this special space. The calming sound of a heartbeat and distant music keep you company as you drift into slumber.” Five participants specifically mentioned that they use the ‘Home’ soundscape to help bring themselves or their child to sleep. The composition of ‘Home’ could be described as containing elements that are monotonous and muffled, where layers of audio are sounding simultaneously. There is a regular drone of harmonies that come and go in waves. Each wave gradually crescendos and decrescendos, with a period of about 10 seconds. Underneath the layer of waves, a pulsing beat can be heard throughout

the track (in particular, at 33 minutes into the track), evoking the sounds of a heartbeat inside the mother’s womb. In between hearing the sound of waves and heartbeat, modulated broadband noise mimics sound transmitted through amniotic fluid. As all three layers are combined, care-givers use the track for both themselves and their child in a manner that resembles shutting down the mind and body to rest, just like an unborn baby is sheltered from the outside world while resting in their mother’s womb [17]. In particular, P12 mentioned the soundscape “Home”, as being most calming, saying that “the subtle heartbeat sounds help calm my son to sleep”. This particular participant enjoyed playing ‘Home’ for his son, and reported a decrease in anxiety and undisturbed sleep. Thus, it is not a type of stimuli that would arouse the listener, but rather create a comforting environment to support sleep, and its potential to support sleep in infants was espoused by Mazzarolo [17].

The incongruence between sound and place can remind individuals of times when they were connected to nature [23]. Even though ‘Home’ was the single most favoured soundtrack (Figure 4), the majority of selected soundscapes were water-based (i.e. ‘Rain’, ‘Ocean’ and ‘Waterfall’). This was attributed to the participants having been to a place where they have seen rain, an ocean or a waterfall, being suggestive of the Association theme. As a further example of this association between sound and place, P5 comments “If we have been to the beach that day, they always pick ocean”. P5 plays the soundscape ‘Ocean’ for their kids throughout the night as a reminder of the past events they had enjoyed or would want to relive the experience. P40 listened to ‘Stars’ whilst watching the stars before sleep in order to calm down to “help with faster sleeping”. Both these participants have associated music with activities performed earlier.

4.2.3 Habit formation and non-sleep related reasons

We were not unanimous in choosing Habit as a theme into which responses could be placed, because those responses generally overlapped with other themes (hence not shown in Figure 3). However, habit formation has in recent years been proposed as possible explanation why playing music each night is a successful way of aiding sleep [18, 24]. In the present study, most participants played *Sleep Through* as an indication that it is time to go to bed, with explicit example such as “I use it to get to sleep” (P7), “to assist with falling asleep” (P4) and “to assist my 2year old in settling for sleep – she seems to have a good association between the music and sleep” (P6). Habit was included in an alternative version of our thematic analysis. We decided to omit Habit as a theme in our final analysis because of its considerable overlap with the Relaxation theme and because some habit related responses could be incorporated into the Association theme. With the alternate analysis, the theme Association linked with the subtheme 'sound and place', and Time related references became as sub-theme of Habit signalling bedtime: "I use it to get to bed", "assist with falling asleep" etc. Furthermore, the responses related to breastfeeding also fitted comfortably as a sub-theme of Habit formation. For the interest of the reader, Figure 5 shows this alternate theme map that includes Habit.

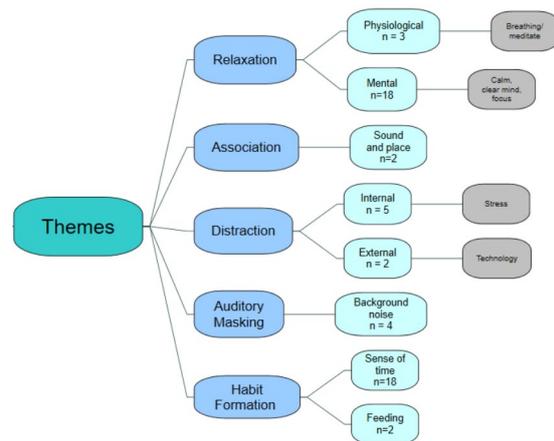


Figure 5. Alternate theme map from the *Sleep Through* survey, with the Habit theme included. Notice the large number of overlapping themes. See Figure 3 for more details.

4.2.4 Distraction

Sleep Through was beneficial because engaging in the soundscapes diverted the listener from focusing on stressful thoughts. Five participants in the present study expressed that *Sleep Through* helped reduce distractions from their own thoughts, as shown in Table 2. Notice the considerable overlap between this theme and the Relaxation theme discussed above. Indeed, it may be possible that relaxation mediates sleep, and distraction is a means to facilitate relaxation, but in and of itself does not offer a direct psychological pathway to sleep [for further discussion see 25].

Participant	Response classified as Distraction theme
P15	“I find ‘Rain’, ‘Forest’ and ‘Bushland’ most relaxing and the repeat of sounds helps me to focus on sound rather than running over things in my head”.
P17	Plays all the nature soundscapes for her daughter to “stop and slow down to go to sleep”
P5	Uses <i>Sleep Through</i> to help switch off at night – “my son is always thinking and my daughter fidgets a lot”
P40	Plays <i>Sleep Through</i> to “help destress and help with faster sleeping”
P41	Uses <i>Sleep Through</i> “for my brain to slow down”.

Table 2. Response classified of Distraction theme

Not only do internal distractions contribute to the interference of focus, but external distractions are also factors that involve visual triggers and online social interactions via the use of technology. From the survey, 2 participants reported using *Sleep Through* as a way to fix the previous bad habits when getting into sleep for healthier sleep habits. Notice again the overlap between themes, this time between distraction and the possible theme of habit. P16 uses *Sleep Through* to “avoid watching movies while he falls

asleep” and P39 plays *Sleep Through* in bed to limit the use of being on the phone scrolling through social media. Both of these participants wanted to reduce the amount of time spent on technology that could potentially tire the eyes. Brockmann, et al. [26] mentions evening exposure from watching television is associated with poor quality sleep in preschool children, due to the constant light exposure in a dark room. Long-term blue light exposure via phones, television and computer screens can damage the photoreceptors in the eye [27]. Hence, the option for having soundscapes running in the background is a more subtle approach in getting the child to bed.

4.2.5 Auditory Masking

Auditory masking drowns out or minimizes unwanted background noise enabling focus on the sounds we want to hear and can be applied to music to aid sleep [7]. The unwanted sounds can be intermittent sounds filling our surrounding environment, causing a disturbance for both the individual and surrounding people [7]. Hence, the hustle and bustle of unwanted sounds during sleep can cause poor sleep quality and quantity. Three participants reported using *Sleep Through* for their child and themselves before bed by leaving the playlist running throughout the night with P8 saying “I use it for the toddler as background sound to sleep and aid uninterrupted sleep”. P6 says “It assists in blocking background noise in the house” and P12 enjoys the “calm sounds that play softly in the background and help drown out sounds of the rest of the house.” Likewise, Xie, et al. [28] investigated the influence of ocean sounds on sleep patterns in an intensive care unit. Patients who were grouped to a condition for receiving ocean sounds (based on white noise stimulus) reported higher scores in the quality and quantity of sleep than those who had to slept with no music or sound. This was explained in terms of patients exposed to ocean sounds feeling a ‘low’ level of arousal, putting them in a state of calmness resulting in better sleep. However, there can be sounds in the sleep-aiding stimulus which may inadvertently interfere with sleep resulting in participants being woken up. P12 continued “I always wake up to the sky soundscape. The ping and bong noises are too high pitched.” As our brain is constantly active in cycling through REM and NREM stages of sleep, sudden high pitched, loud sounds may result in the disruption of sleep, providing ineffective masking of environmental sounds [15]. In this case, the occasional high-pitched sounds reported by P12 was more overbearing than the unwanted noise, resulting in P12 waking up in the middle of the night.

4.2.6 Other uses of *Sleep Through*

Even though *Sleep Through* was aimed to induce sleep, adults reported using these soundscapes for non-sleep related applications. P39 said, “When I’m listening to *Sleep Through* whilst studying, I find myself concentrating more and being in the zone.” Although not the specific aim of the soundscapes, the response should not be that surprising, with evidence existing, for example in research by Newbold, et al. [23] that auditory stimulation can help maintain attention and concentration.

Also not directly related to supporting sleep was the reported use of the soundscapes for breast feeding. P3 was explicit in reporting benefits to both sleep and breast feeding, using *Sleep Through* “To sleep calmly and soundly than before. Also, for my nearly 2-year-old to settle straight back to sleep after her breastfeed together”. Similarly, P8 used *Sleep Through* “for a small baby when up feeding throughout the night to aid uninterrupted sleep and help join sleep cycles.” Music used in breast feeding enhances the attachment between the mother with her infant [29].

5. CONCLUSION

This paper investigated audience responses to the soundscapes composed as part of the ABC commissioned series *Sleep Through* composed by author AH. When prompted for the reasons that the compositions were selected, and to assess their efficacy, an overwhelming number of responses were consistent with established views on how music is used to aid sleep for adults, with key themes being Relaxation, Association, Auditory Masking, Distraction, and Habit. Relaxation was most frequently reported, and some overlap between relaxation and distraction were also observed. The ‘Home’ soundscape was the most frequently selected by the sample, possibly because of its association with events in the day, or because it applied sounds that mimic gestational womb sounds, triggering the comfortable past for the infant. The water-based connection as an explanation of the soundscapes is also reflected in the frequent choice of water-related soundscapes by the participants, although this too was frequently related to activities that took place during the day, such as going to the beach. The proposed themes while distinct, showed numerous cases of overlap.

The compositions were also considered highly useful in helping young families commence and maintain healthy sleeping behaviours, but interestingly other, non-sleep benefits were observed, including using the soundscapes for breast feeding, or purely for pleasure.

The near absence of criticism of the works is encouraging in identifying alignment of the initial propositions with the reception of the works, keeping in mind that respondents were drawn from the ABC’s social media channels and therefore more likely to have self-selected according to positive associations with the brand. Some of the works surveyed were composed during and after research from Mazzarolo [14], speaking to the growing dialog between the community, composer and empirical researchers surrounding this unique broadcast. The one finding that contradicted initial compositional premises (namely the impact of short, high sounds in one piece) affords a valuable insight for future compositions. Also interesting is the close alignment between the empirically arrived at themes and three of the four foundational approaches reported by the composer: Auditory Masking; Relaxation through Entrainment, and; Association and Familiarity.

The study is obviously limited, in that the participation rate was small, due in part to the ethics requirements. The ethics requirements required detailed explanations. Since participants were given the option of identifying them-

selves, they needed to be aware of this before commencing, if they agreed to participate. This was a factor in dissuading a larger sample from participating. The quantitative results were therefore presented in descriptive form only, but those data and the examination of the open-ended responses still produced responses consistent with previous research, which was largely based on adult uses of music for aiding sleep.

The current study, for obvious reasons, relies upon adults reporting infant experiences, and future research will be needed to determine what special aspects of music and soundscapes might need to be adapted to better serve infant sleep. But our findings are consistent with the theoretical position of the kind of music that might be suitable for infants as proposed by [17], as well as the literature highlighting musical characteristics most preferred by adults to facilitate sleep [15]. While larger-scale studies await, our findings suggest that there are some commonalities in the approaches to sound throughout the *Sleep Through* series that support sleep, and that these can be further developed to support the positive health outcomes that result from a good night's sleep for both children and adults.

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