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Development of an Inclusive and Accessible Non-pharmacological Sleep aid Device

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Abstract **—** *Sleep is a vital physiological process essential for physical and mental health, characterised by reduced sensory activity and altered consciousness. Quality sleep enables critical functions such as tissue repair, memory consolidation, hormone regulation, and emotional stability. Conversely, inadequate sleep can lead to significant health issues, including mood disturbances, cognitive impairments, and increased risk of chronic conditions. Many individuals experience difficulty transitioning into the N1 stage of sleep which is the initial phase also known as the first stage of our sleep cycle where the body moves from wakefulness to sleep-often due to psychological factors, particularly stress. Consequently, there is an urgent need for effective, non-pharmacological interventions that can assist individuals in achieving a smooth transition from wakefulness to sleep. This research investigates the key parameters of sensory stimulation—specifically visual, olfactory, and auditory stimuli—that can be recommended for designing an effective non-pharmacological sleep aid device. stimulating sensory organs can enhance melatonin production, which is known to be the sleep-promoting hormone. non-pharmacological treatments account for a significant portion of sleep interventions; however, there is a lack of targeted research on visual stimulation techniques and their effectiveness in enhancing sleep onset. The study aims to explore how specific sensory stimuli can aid in the transition from wakefulness to sleep, especially for individuals experiencing sleep initiation difficulties linked to psychological factors. The primary objective is to identify non-invasive, sensory-based methods that promote relaxation and support sleep onset. Additional objectives include conducting pilot studies to evaluate the effectiveness of various stimulation techniques on sleep quality within a selected participant group, gathering and analysing data to establish optimal stimulation parameters, and providing recommendations that can guide the design of a sleep aid device. The methodology was structured to build a foundational understanding of sleep, beginning with the development of a framework for analysing sleep-related factors. Initial data collection involved survey studies, with an online survey yielding 72 responses, followed by printed questionnaires distributed to additional participants. Together, these methods provided a comprehensive set of insights that confirmed the validity of the research's direction. Subsequent test runs were organised to individually evaluate the effectiveness of each type of sensory stimulation, with participants completing feedback forms after each trial. User tests were conducted with six volunteers over nine*

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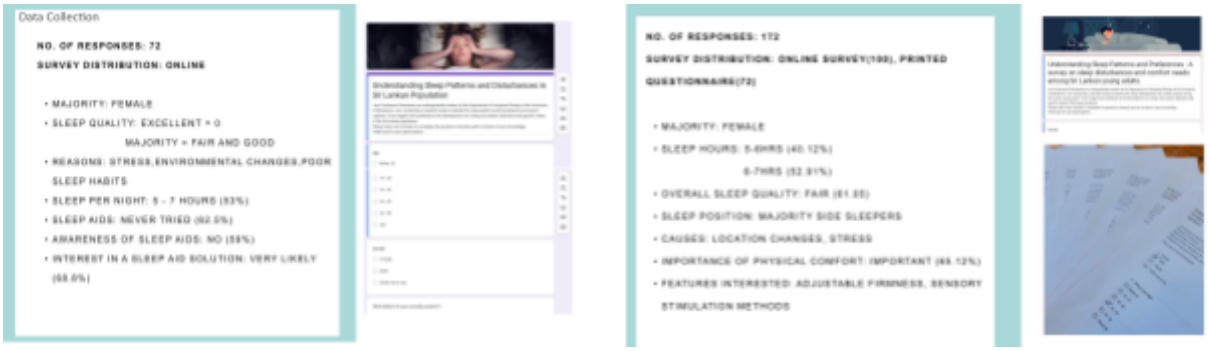
nights, during which qualitative feedback was collected through structured questionnaires following each testing session. For visual stimulation, an experimental prototype was developed, featuring a pendulum with an amber light that gradually faded to darkness. This prototype was designed to be placed on the nightstand, where participants could observe the motion and light while preparing for sleep. In the olfactory stimulation test, participants received a choice of three essential oils—lavender, rose, and jasmine—based on individual preference, with instructions to spray the chosen oil before bedtime. Finally, for the auditory stimulation test, participants were provided with links to various relaxing soundscapes, which they could listen to via speakers or earbuds during their bedtime routine. Feedback gathered from each of these tests was synthesised into a feedback grid, leading to key findings that informed the final design requirements: the sleep aid device should prioritise external sensory stimulation to encourage relaxation, accommodate side and back sleepers, and offer customizable settings for each sensory mode. Additional features deemed essential included sleep-tracking capabilities, mobile compatibility, integration as a smart device, and rechargeable functionality. Participants expressed a preference for a device design incorporating white and blue shades, with amber lighting as the ideal light condition for sleep induction. Lower colour temperatures (2500K – 2700K) were identified as optimal for promoting relaxation and enhancing sleep quality. Furthermore, the repetitive motion of the pendulum was effective in reducing eye strain and encouraging a state of calmness conducive to sleep. In conclusion, this research provides a foundational understanding of sensory-based parameters that can be applied in the design of a sleep aid device, highlighting the potential of non-pharmacological, sensory-driven interventions to improve sleep onset and overall sleep quality. These findings offer actionable insights into sensory parameters that can guide the development of inclusive and effective sleep aid solutions for diverse users.

Keywords: *Sleep, psychological factors, N1 stage, sensory stimulation, non-pharmacological*

Figure 1
Summary of the Online survey and printed Questionnaire papers



Note. Created by the author

Figure 2
Light therapy, Aromatherapy, and sound therapy prototypes made for test runs

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