Research Article

Enhancing Finger Sensitivity: Sensory-based Activity Module (*Sensory-BAM*)

Khairina Iqlima Batrisyia Khairil Anuar[1], Nurinsyirah Najihah Izharruzzahir[2], Mohd Shaiful Sajab[3], and Hatika Kaco[4,*]

1 Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800, Nilai, Negeri Sembilan, Malaysia; kbatrisyia.ka@gmail.com; 0000-0003-4152-8840

2 Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800, Nilai, Negeri Sembilan, Malaysia; insyirahnajihah66@gmail.com; 0000-0003-1219-4378

3 Department of Chemical and Process Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia; mohdshaiful@ukm.edu.my; 0000-0001-8400-8090

4 Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800, Nilai, Negeri Sembilan, Malaysia; hatikakaco@usim.edu.my; 0000-0002-8359-9359

* Correspondence: hatikakaco@usim.edu.my; Tel: +6019-8435304.

Abstract: Visual impairment and blindness constitute a prevalent global health concern, significantly impacting individuals with visual impairments and those in their immediate vicinity, thereby exerting a substantial societal disability. Sighted individuals do not encounter the same range of difficulties in their daily routines and learning as those faced by individuals with visual impairments. Nevertheless, despite the obstacles they encounter, individuals with visual impairments heavily rely on their tactile and auditory senses to gather information from the environment. As a result, they may necessitate assistance or utilize tools that can enhance their sensory acuity. Consequently, engaging in sensory activities enables individuals with visual impairments to enhance their finger sensitivity, thus facilitating sensory exploration. Consequently, the objective of this study was to investigate the potential of integrating sensory activity in the form of a module with game-based activities as a means of enhancing finger sensitivity. This was achieved by creating a sensory based activity module (sensory-BAM) that could be used to instruct individuals on how to improve their finger sensitivity. Sensory-BAM utilizes tactile activities and integrates various skills, including communication, leadership, teamwork, and creativity to achieve the learning outcomes a) increase finger sensitivity, b) recognize the texture of the materials used and c) increase hand's strength. Therefore, a series of activities were organized, with each activity station offering a unique game that utilized different materials, such as sand, rice, fingerpaint, and playdough with different missions. Every prepared activity was centered around a tactile experience that is appropriate for enhancing finger sensitivity. Sensory-BAM consists of four game stations prepared for all participants including sand, paint, playdough and rice as the main item for improving finger sensory. Ergo, this engaging activity-game learning approach provides visually impaired individuals with a practical way to improve their tactile sensitivity and specially for visually impaired in learning Braille.

Keywords: braille; game stations; index and middle fingers; sensory play; two-point discriminator

DOI: 10.5281/zenodo.8031045

1. INTRODUCTION

Blind people encounter substantial obstacles while navigating their everyday routines due to the profound physical and mental impact of vision loss. This heightened vulnerability exposes them to elevated risks, resulting in concerns, loneliness, and challenges in adjusting to unfamiliar environments. (Awad et al. 2020; Kaco et al. 2021; Kaco et al. 2022). It is widely recognized that individuals who are blind primarily depend on reading braille, facilitated by their enhanced finger sensitivity (Kaco et al. 2021). Braille plays a crucial role in their everyday lives, particularly in public settings. Braille is a tactile system created specifically for blind individuals, utilizing raised dots to represent letters of the alphabet. To read braille, individuals trace their hand or hands along each line, moving from left to right (Alnfiai & Sampalli, 2016; Awad et al. 2020).

The epidermal ridges on the fingertip surface give rise to varying levels of finger sensitivity among individuals. These ridges enable humans to distinguish between an extensive array of textures, materials, temperatures, and pressures (Kaco et al. 2021). It should be emphasized that every individual has a unique arrangement of ridges, but this arrangement does not affect their sensory capabilities (Kaco et al. 2021). Studies have shown that children display heightened tactile sensory skills in comparison to adults. The size of their fingertips can impact finger sensitivity, as children with larger fingertips tend to exhibit lower acuity. It is worth noting that during the growth process, tactile acuity has the potential to undergo alterations (Appiani et al. 2020; Peters & Goldreich, 2013). Numerous studies consistently demonstrated that as adults grow older, there is a consistent decrease in their passive tactile spatial acuity.

Adults who encounter vision loss as a result of an accident face unique challenges in their everyday lives. One of the key questions is how they adapt and cope with these changes. Specifically, can they still read braille effectively despite experiencing a decline in finger sensitivity? The ability to read braille relies heavily on the tactile sense, requiring individuals to discern and interpret raised dots with their fingertips. However, it's important to consider that diminished finger sensitivity might impact their ability to perceive these tactile patterns accurately. Therefore, understanding the strategies and techniques that visually impaired adults employ to navigate their daily lives and maintain their proficiency in braille reading is of great significance.

Therefore, in this study, sensory-based activity module (sensory-BAM) was developed aimed to integrate sensory activities approach and finger sensitivity measurement in a module. The primary purpose of this module is to enhance finger sensitivity among individuals with visual impairments and those who have recently experienced vision loss and are beginning to learn braille. Consequently, the enhanced finger sensitivity will provide valuable assistance in guiding individuals throughout their daily routines.

2. DESIGN MODULE AND PLANNING

The development of a sensory-based activity module, known as sensory-BAM, aimed to evaluate and improve finger sensitivity, specifically for individuals with visual impairments resulting from either congenital blindness or sudden loss of vision. The ultimate goal was to support their Braille learning for reading and enhance various skills. To achieve this, a series of activities were designed, each presented at a unique station featuring materials like sand, rice, fingerpaint, and playdough, with specific missions tailored to enhance finger sensitivity, as illustrated in Figure 1.

Figure 1. Sensory-BAM flow activities

3. IMPLEMENTATION OF SENSORY-BAM

The sensory-based activity module, known as sensory-BAM, consists of a total of four game stations. Each participant will be assigned to a group of five members in total. The first station, called the sandplay station, involves three trays filled with different textures of sand. Hidden within these trays are treasures that participants need to find. Once found, they must recreate the treasures using another type of sand provided. This process is repeated for all three trays in a sequential manner. The mission is considered complete when all participants have finished recreating the treasures. At the conclusion of the mission, an instructor will assess the participants' finger sensitivity with the assistance of the participants. Figure 2 summarizes the sandplay game station.

Figure 2. Game Flow for Sandplay Station

For each group, the fingerpaint station offers five drawing sheets and a variety of paint colors. The instructor reads out riddles, which the participants must discuss with their group members and then depict using their fingers and the provided paints. The mission concludes with the instructor evaluating the participants' finger sensitivity. Figure 3 shows the summary of the fingerpaint game station.

Figure 3. Game Flow for Fingerpaint Station

At the playdough station, the team members are provided with clay, playdough foam, and regular playdough. Each team receives 300 g of each playdough type. Participants select a paper slip from a container, which determines the shape they need to create. The instructor chooses the type of playdough for each round, and the participants use it to mould the assigned shape. Following the completion of the mission, the instructor assesses the participants' finger sensitivity. Figure 4 shows the summary of the playdough game station.

Figure 4. Game Flow for Playdough Station

In the rice play station, each group is provided with three large ziplock bags and three different food colorings. The station includes Basmati rice, white rice, and ponni rice, with a separate bowl for each type. Participants are instructed to place the rice into a ziplock bag and add a tablespoon of vinegar. They then choose a food coloring and add it to the same ziplock bag. After sealing the bag, they mix the rice thoroughly. Once the materials are well-mixed, the participants spread the rice on wax paper to allow it to dry. Finally, they use the colored rice to create a free-form drawing on a frame. At the conclusion of the mission, the instructor evaluates the participants' finger sensitivity. This rice play game station was summarized in Figure 5.

Figure 5. Game Flow for Rice Play Station

4. FINGER SENSITIVITY EVALUATION

Finger sensitivity was conducted using the baseline two-point discriminator (TPD) as a measurement tool (Figure 6). The two-point discrimination test is employed to evaluate the individual's capacity to discern closely spaced points on a specific area of the skin and assess the precision of their discriminatory abilities in that region. It serves as a measurement of tactile agnosia, which refers to the ability to recognize these two points accurately despite having intact cutaneous sensation and proprioception (Rea, 2015). The two-point discrimination test is a traditional assessment that evaluates an individual's ability to distinguish the distance between two compass points, representing the sensation of feeling two separate contacts. This method has been employed to gauge the recognition capability of tactile touch, specifically in identifying whether two points are perceived as separate or not (Lin & Rugaman, 2015).

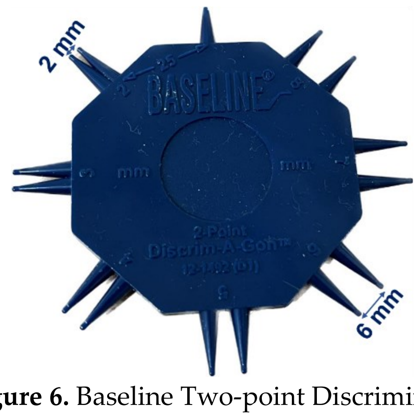

Figure 6. Baseline Two-point Discriminator

During the test, the device was used by positioning its two tips on the designated test site. The stimulus intensity was carefully adjusted to a level where the subject could feel a consistent sensation of touch or movement without encountering any discomfort or pain. The selection of the index fingertip for examining the sensory sensitivity of the subjects was randomized, either from the left or right side. The testing process commenced with the index finger and then continued to the middle finger sites, alternating between the right and left sides for each subsequent test (Won et al., 2017).

The TPD test began with an initial distance of 10 mm, which was gradually reduced to 5, 4, 3, and 2 mm. If the subject was unable to perceive the initial distance accurately, a longer distance was employed as the initial distance. A threshold was established using a descending stimulus magnitude, and an intermittent point was introduced during the descending series to prevent the subject from anticipating a continuous decrease in the distance between the two points. If the subject responded correctly to the changes, the distance between the points decreased in 1 mm intervals. This process continued until the subject answered incorrectly, at which point the experimenter returned to the next longer distance, indicating the endpoint of the TPD test (Dane et al., 2017; Won et al., 2017;). The subjects were given three alternatives for their answers: stating "one" if they felt one point, "two" if they perceived two separate points, or "I can't discriminate one or two" if they were unable to differentiate between one or two points. Any response other than these options was considered an incorrect answer. The summary of the test flow presented in Figure 7. All of the tests were conducted in a quiet room at room temperature by a single instructor. The subjects were instructed to keep their eyes closed throughout the entire test procedure.

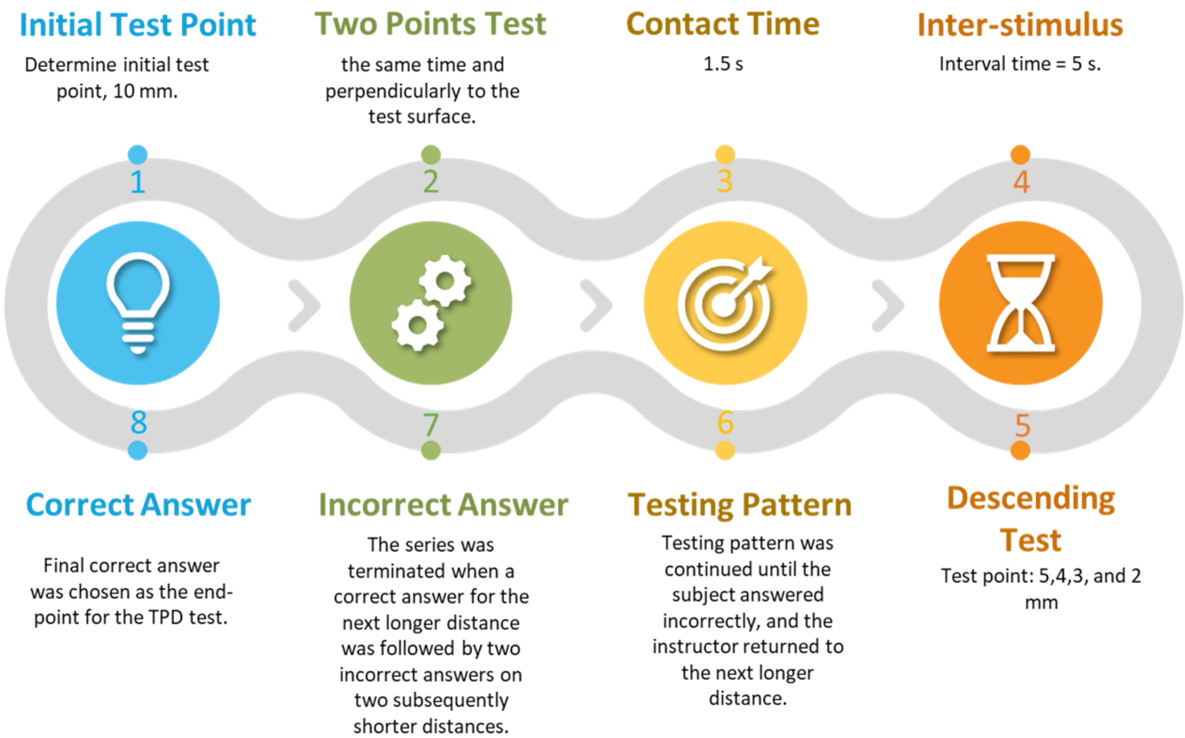

Figure 7. Finger Sensitivity Test Method

4. IMPACT AND FUTURE PROSPECTS

The implementation of Sensory-BAM has a beneficial effect on finger sensitivity as summarized in Figure 8. By enhancing finger sensitivity, individuals can more effectively learn braille and improve their ability to read it. Moreover, this heightened sensitivity allows them to easily recognize objects through touch, particularly when utilizing accessible facilities designed for individuals with disabilities. It also enables them to interact with their environment without hesitation or fear of touch, fostering greater independence and confidence.

Figure 8. Impact of enhanced finger sensitivity

This study aimed to expand the Sensory-BAM for braille learners for better future prospect as summarize in Figure 9. One of the planning and prospect after Sensory-BAM is braille class session. This class will be starting point for braille learners once individuals achieve a significant improvement in finger sensitivity, reading Braille becomes more accessible to them. Consequently, there are plans underway to organize a Braille teaching session in the near future. Besides, Braille can be incorporated into storybooks by adapting them into the format of Braille cassette tapes, making it more convenient for individuals with visual impairments to access and enjoy the stories. Meanwhile, to cater to blind Muslims, the invention of Quran Braille has been introduced. Additionally, Braille cassette tapes have been developed to provide a simplified means of accessing the Quran for individuals with visual impairments.

Figure 9. Future prospect after Sensory-BAM

5. COMMERCIALIZATION POTENTIAL

The Sensory-BAM module exhibits considerable commercialization prospects as a valuable reference tool for the visually impaired. In Malaysia, the distribution of this module can be effectively managed through KL Braille, the nation's leading distributor of Braille resources. In terms of safeguarding intellectual property, the module is currently undergoing the registration process for copyright protection.

6. CONCLUSION

In summary, the development of Sensory-BAM has brought about a transformative shift in the learning methodology for visually impaired individuals by harnessing sensory play to effectively tackle their distinct challenges. Sensory-BAM has been meticulously crafted, incorporating four engaging sensory play activities. Through the integration of a finger sensitivity test, the implementation of Sensory-BAM has demonstrated remarkable success in enhancing participants' tactile sensitivity while introducing a fresh and innovative learning experience. This alternative approach holds substantial significance in supporting individuals who have recently experienced vision loss, as it improves their finger sensitivity and plays a pivotal role in their ability to read Braille and actively engage in daily activities.

Acknowledgments: The author extends heartfelt appreciation to the students of Kolej GENIUS Insan for their invaluable support and contributions during the implementation of the Sensory-BAM. This research paper has received funding from Universiti Sains Islam Malaysia (PPPI/KGI/0119/051000/16019) and Universiti Kebangsaan Malaysia (PDI-2021-007).

References

Alnfiaia, M., & Sampalli, S. (2016). SingleTapBraille: Developing a text entry method based on braille patterns using a single tap. Procedia Computer Science, 94, 248 – 255.

Appiani, M., Rabitti, N.S., Methven, L., Cattaneo, C., & Laureati, M. (2020). Assessment of Lingual Tactile Sensitivity in Children and Adults: Methodological Suitabilityand Challenges. Foods, 9, 1594-1617.

Awad, A., Yao, A., Trenfield, S.J., Goyanes, A., Gaisford, S., & Basit, A.W. (2020). 3D Printed Tablets (Printlets) with Braille and Moon Patterns for Visually Impaired Patients. Pharmaceutics, 12, 172-185.

Dane, A.B., Teh, E., Reckelhoff, K.E., & Ying, P.K. (2017). Differences of Cutaneous Two-Point Discrimination Thresholds Among Students in Different Years of a Chiropractic Program. Journal of Manipulative and Physiological Therapeutics, 40(7), 511-516.

Kaco, H., Norhisyam, I.A., Rahmat, M.A.R., Ruslan, N.H., Idris, F.M., Jan, N.M., Mohd, S.M., & Sajab, M.S. (2022). The Essence of Practicing 3D Printed Models through Gamebased Module in Learning Braille Quran Code among the Beginners. International Journal of Academic Research in Progressive Education and Development, 11(3), 664-675.

Kaco, H., Norhisyam, I.A., Rahmat, M.A.R., Ruslan, N.H., & Sajab, M.S. (2021). A study on Two-point Duscrimination Tactile Sensory for Reciting Quran Braille Dots. Proceeding of the 7th International Conference on Quran as Foundation of Civilization (SWAT), Universiti Sains Islam Malaysia, 6-7 October 2021.

Rea, P. (2015). Chapter 8 - Spinal Tracts – Ascending/Sensory Pathways, Editor(s): Paul Rea, Essential Clinical Anatomy of the Nervous System, Academic Press, 133-160.

Lin, R.F., & Rugama, A.D. (2016) Graphical message transmission using the monotonic vibration function of a smart phone. Ergonomics, 59:2, 235-248.

Peters, R.M., & Goldreich, D. (2013). Tactile Spatial Acuity in Childhood: Effects of Age and Fingertip Size. PLoS One, 8(12), e8465.

Won, S.Y., Kim, H.K., Kim, M.E., & Kim, K.S. (2017). Two-point discrimination values vary depending on test site, sex and test modality in the orofacial region: a preliminary study. Journal of Applied Oral Science, 25 (4), 427-435.