

Validity and test-retest reliability of a kinesthetic perception test for blind people

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ABSTRACT

Blind people need kinesthetic perception as feedback for providing information related to movement characteristics, such as position in space and direction. The research purpose was to determine the validity and test-retest reliability of a kinesthetic perception test for blind people. The test consists of placing both the feet correctly on 4 square targets (5 cm thick) placed on the right, left, front, and back, at a distance of 100 cm from the initial position that is located in the middle, following the audio stimulus with a time limit of 10 seconds per repetition. The researchers used 3 experts to evaluate the validity of the test. The test-retest reliability was evaluated in a total of 50 people who were totally blind. Aiken V coefficient was used to test the validity and Cronbach's alpha correlation test was used to test the test retest reliability. The research results showed a value of Aiken V of $0.86 > 0.77$, and a reliability of $0.816 > 0.60$. Therefore, it can be concluded that the kinesthetic perception test for blind people presented in this manuscript is valid and reliable.

KEYWORDS

Validity; Reliability; Kinesthetic Perception; Blind

1. INTRODUCTION

Blindness is one of the types of sensory disabilities that make people with vision problems to experience obstacles and limitations in moving, and to have dependence on other people to enter new or unknown environments. The definition of blindness is based on foveal vision (central vision), and most of the blind people have some light perception, indicating some peripheral visual function (Castro et al., 2021). As a result, blindness causes limitations in the variety of experiences, movement or mobility, and interacting with the environment. Blindness causes inhibition of motor development to perform physical activity. The visually impaired show progressive visual impairment

due to retinal degeneration and corneal clouding, leading to blindness, achlorhydria, worsening of muscle hypertonicity, and decreased motor function (Misko et al., 2022). Motoric is the development of maturity element control of body movements and brain as a center of motion. Optimal motoric performance needed kinesthetic feeling.

Blind people have limitations in their physical condition, namely the presence of visual impairments in carrying out all daily activities. Blind people use hearing, touch, and smell in carrying out their activities. Therefore, the visually impaired require high kinesthetic sensitivity. Blind people need kinesthetic perception as feedback in providing information related to movement characteristics such as position in space and direction. Kinesthetic awareness of skills will develop, improve and integrate work movements using tools through stages of practice that constantly develop sense and through these stages hand and finger movements and levels of vision that are formed as a result of muscle ability and performance kinetic sense perception and sending skills is one of the technical skills (Ali & Saleh, 2021). The quality of kinesthetic perception is not good, there is a tendency to find it difficult to control the position and movement that has been done. On the other hand, a good kinesthetic perception quality will certainly be able to control the position and motion that has been done, so that if the movement is correct and on target there is a tendency to repeat the same position or motion with careful movement control. Carefully controlled movement is a proponent of efficient movement.

Research suggests that tactile-face perception activates the occipito-temporal cortex in the congenitally blind (CB), late-blind (LB) and blindfolded-sighted (BF) groups. However, the non-visual drawing exercise resulted in reorganization of most of the left brain in both groups of visually impaired, in contrast to the right brain in the blindfolded-sighted (BF) group, i.e. the post-exercise response changes were stronger in the left brain in the blind, but in the right brain in the blindfolded-sighted (BF) group. In this face perception, learning-based changes positive were in the congenitally blind (CB) and blindfolded-sighted (BF) groups, but negative in the late-blind (LB) group (Likova, Mei, Mineff, & Nicholas, 2019). Kinesthetic awareness is how a person can perceive their environment through sensory stimulation of the skin. Through visual media, some blind individuals rely more on their sense of hearing and touch to learn something (Atteng, 2021). In this context, our research purpose was to determine the validity and test-retest reliability of of a kinesthetic perception test for blind people.

2. LITERATURE REVIEW

2.1. Blind people

Blind people are individuals who experience damage or obstacles to the eye organs. Blindness is defined as visual acuity less than 3/60, or associated with a visual field loss of less than 10 degrees in the better eye with the best possible correction (Van der Ham et al., 2021). The definition of blindness does not only refer to those who are blind, but also includes those who are able to see but are very limited and cannot be used for the benefit of daily life, especially in learning. So, individuals with vision conditions that include “half-vision”, “low vision”, or farsightedness are part of the group of blind people. A person is declared blind if after making various efforts to improve his visual ability, it turns out that his visual acuity does not exceed 20/200 or after all efforts have been made to improve his visual ability, it turns out that his field of view does not exceed 20 degrees. Based on the above definition, visual acuity can be seen in two ways, namely visual acuity and field of vision. Visually impaired people are classified into two groups: totally blind and visually impaired (low vision).

- 1) Total blindness is a complete disability of all the senses of light and is medically recorded as no light perception (NLP) (Abdul Karim, 2020). The condition of vision in total blindness cannot see two fingers in front of him or only see light. They cannot use letters other than Braille. The characteristics of total blindness include physically crossed eyes, frequent blinking, squinting, red eyelids, eye infection, irregular and rapid eye movements, always watery eyes and swelling of the skin where the eyelashes grow. Behaviorally excessive rubbing of the eye, closing or protecting the other eye, tilting the head, or leaning forward, difficulty reading or doing tasks that require eye, more blinking, bringing books close to the eye, unable to see objects that are some distance away, squinting or frowning.
- 2) Low vision is defined as a condition in which a person’s vision cannot be completely corrected with corrective lenses (Alcaraz Martínez, Turró, & Granollers Saltiveri, 2022). Someone who has low vision, when sees something, must bring it closer or the eyes must be kept away from the object or have a blurred view when sees the object. The characteristics of low vision include writing and reading at a very close distance, can only read large letters, the eye looks white in the middle of the eye or the cornea (the clear part in front of the eye) looks foggy, does not look straight ahead, squints eyes or frown,

especially in bright light or when saw something, more difficult to see at night, never experienced eye surgery or wearing glasses and a very thick but still cannot see clearly.

2.2. Kinesthetic Perception

Kinesthetic perception can be interpreted as the process of assessing afferent signals in the reference system provided by efferent processes (Latash, 2021). Perception is a result of the perceptual process. The perceptual process includes three kinds of functions in interpreting the stimulus, namely; 1) detection, 2) comparison, and 3) recognition. Kinesthetic perception refers to the receptors in the muscles and tendons that allow us to sense the poses of our bodies (Sigrist, Rauter, Riener, & Wolf, 2013). Kinesthetic is the difference in position and motion of body parts based on visual, auditory and verbal information. Kinesthetic perception or kinesthetic sense is a function of the organs of the human body which is closely related to body movement, distinguishing the position and movement of the body and limbs both passively and actively. Detection is an attempt to ascertain whether there are stimuli that enter through the senses. Comparison is concerned with determining the similarity of newly entered stimuli with previously received stimuli. Recognition relates to pattern orientation and the nature of incoming stimuli. The sharpness of the perceptual process is an indicator of the quality of the perception of the senses with respect to the sharpness of feeling the position and movement of the body. Awareness of the body in space and the relationship with its parts, the sense of motion shows kinesthetic or also called proprioception. In other words, the kinesthetic perceptual process is influenced by a series of sharp sensing processes so that it can produce carefully controlled movements.

3. METHODS

3.1. Design and participants

Researchers used research and development to design and testing the kinesthetic perception. Research and Development (R&D) is an important element for the creation of innovation, and it is also possible to acquire and use new knowledge (Łącka & Brzezicki, 2021).

Researchers evaluated 50 total blind people aged between 15 to 27 years. Before taking the test, participants signed an informed consent as research sample. The study was approved by the Sebelas Maret University Research Ethics Committee.

3.2. Procedures

Developing a measurement is a complex process involving several stages. The stages of development are as follows (Gall, 2010):

- 1) Define the instrument to be measured and justify the importance of the instrument.
- 2) Define the target population.
- 3) Review the related measures that have been developed and explain why the new measures are needed.
- 4) Develop instrument prototypes and write items that need to be assessed so that the instrument can be understood by the intended population.
- 5) Conduct field trial on measurements and collect data for analysis of each item.
- 6) Revise measurements based on field results. The cycle of field trial and revision can be repeated until the measurement reaches the standard of validity, reliability, and usefulness by the target population.

3.3. Validity and Reliability Test

To assess the validity, the researcher used 3 experts consisting of 1 practitioner (trainer) and 2 academic experts. The experts used have experience as coaches for blind athletes, have knowledge of specific matters related to blind athletes, and have a doctorate degree in sports. Expert assessment using a questionnaire consists of aspects of suitability, safety, usefulness, clarity and implementation. Experts were asked to provide opinions using a Likert scale with a range of 0 - 4 (0 = very inappropriate/safe/useful/clear/implemented, 4 = very suitable/safe/useful/clear/implemented) (Marelli et al., 2021). Researchers used 50 total blind people to test the reliability who were tested using a kinesthetic perception test. The test was carried out twice in 2 different days.

3.4. Data Analysis

Liliefors test was used to determine if the data was normally distributed. The Aiken V coefficient was used to test the validity of the expert assessment results (Meléndez-Jara, Ramírez-Sáenz, & Tafur-Mendoza, 2021). To achieve a 99% confidence level, an Aiken V value of 0.77 is required. Researchers also examined the relationship/correlation between the test retest using the correlation test. Cronbach's alpha > 0.60 indicates that the test is reliable.

4. RESULTS

The test consists of placing both the feet correctly on 4 targets placed on the right, left, front, and back, at 100 cm from the initial position located in the middle, following the audio stimuli presented (Figure 1).

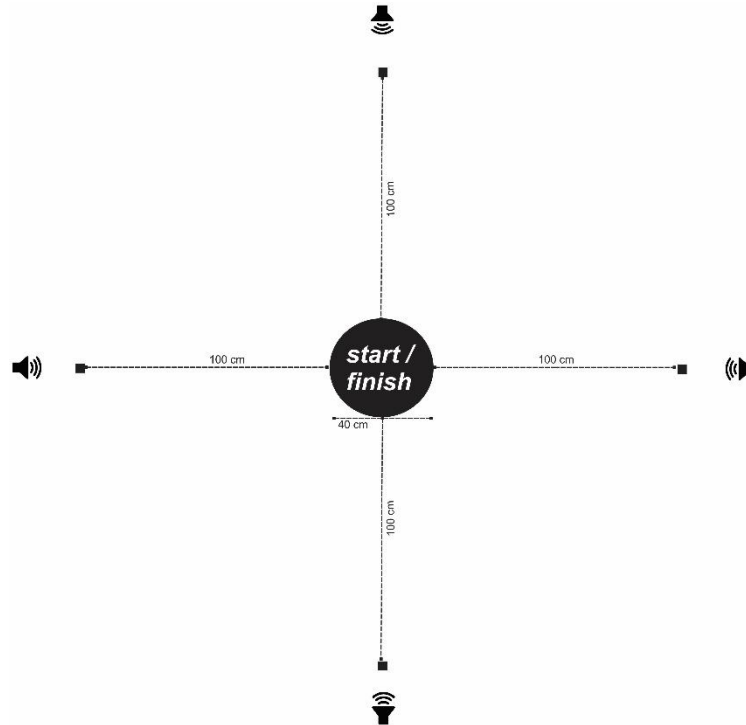


Figure 1. Test designed

The instructions of the test are the following: 1) Testee stands in the starting position. 2) The testee's feet are assisted by the examiner to be placed in the target position. After that return to the original position. 3) After the testee feels ready, the testee is instructed to place both feet on the target with the signal "tut" sound stepping foot one by one. 4) The test is carried out four times (right, left, front, back) with three repetitions. 5) The test has a time limit of 10 seconds for one repetition.

Experts assessment to test the validity of the test instrument was developed. The results of the expert assessment are described in Table 1. Table 1 shows the value of Aiken V on each item assessed by experts. Judging from the average Aiken V value, which shows $0.86 > 0.77$, it can be stated that this instrument is valid. However, there is an aspect of the instrument's ability to measure kinesthetic perception of the blind people based on touch, which shows $0.75 < 0.77$ so the test instrument needs to be revised. The expert gave input to

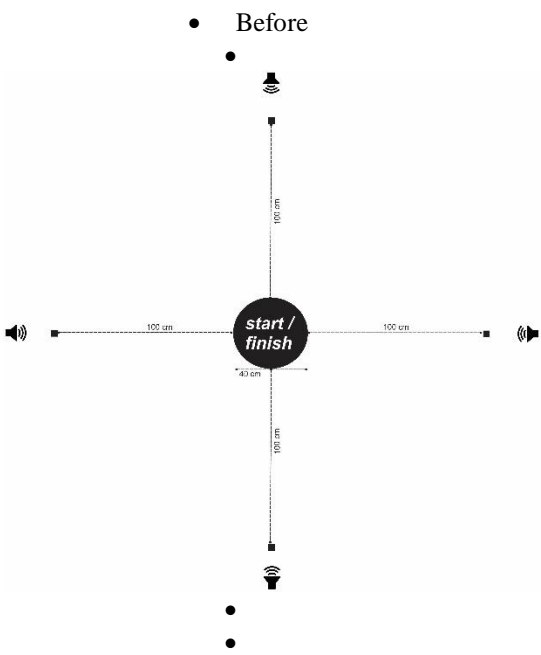
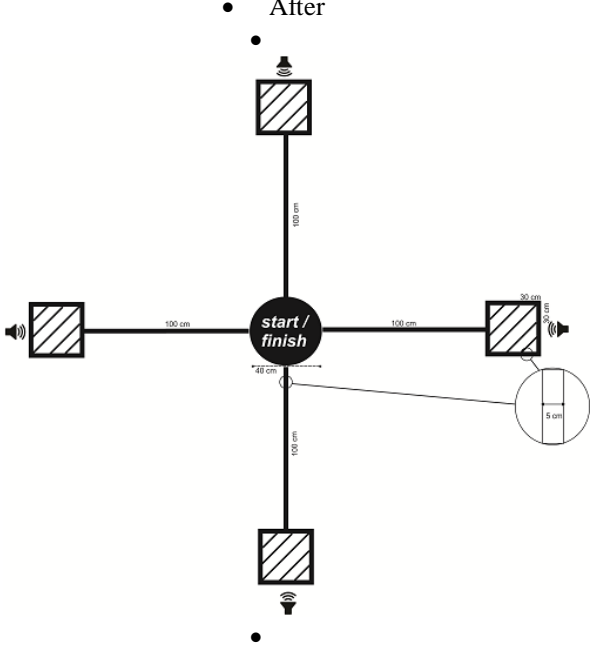
add thickness to the distance line and the target box so that the testee could really touch their position precisely.

Table 1. Expert Assessment Results

Questionnaire Items	V value
Clarity of implementation instructions	0.83
The ability of the instrument to measure the kinesthetic perception of the blind people based on hearing	0.92
The ability of the instrument to measure the kinesthetic perception of the blind people based on touch	0.75
Safe to apply	0.92
The accuracy of the equipment used	0.83
Can improve kinesthetic perception	0.83
Ease of instrument model to do	0.83
The suitability of the instrument model for the blind people	0.83
Instrument model is easy to understand	1.00
Aiken V. Average Value	0.86

Table 2 shows the revision of the test. Changes were done in the shape of the kinesthetic perception test instrument because, according to the experts, the ability of the instrument to measure the kinesthetic perception of the blind people based on touch could be improved. Therefore, it was modified by adding thickness on each line and thickness on the target, so the testees were abler to feel their position by feeling the lines and boxes using their feet.

Table 2. Product Revision

	
<p>The test aims to assess the kinesthetic perception of the blind people. The test consists of placing both the feet correctly on 4 targets placed on the right, left, front, and back, at 100 cm from the initial position located in the middle, following the audio stimulus presented.</p>	<p>The test aims to assess the kinesthetic perception of the blind people. The test consists of placing both feet correctly on 4 square targets with a thickness of 5 cm placed on the right, left, front, and back, at 100 cm from the initial position located in the middle, following the audio stimulus presented.</p>
<p style="text-align: center;">Test implementation:</p> <ol style="list-style-type: none"> 1) Testee stands in the starting position. 2) The testee's feet are assisted by the examiner to be placed in the target position. After that return to the original position. 3) After the testee feels ready, the testee is instructed to placing both the feet position on the target with the signal "tut" sound stepping foot one by one. 4) The test was carried out four times (right, left, front, back) with three repetitions. 5) The test with a time limit of 10 seconds per repetition 	<p style="text-align: center;">Test implementation:</p> <ol style="list-style-type: none"> 1) Targets are placed at a distance of 100 cm to the right, left, front, and back. The target is a box with a thickness of 5 cm. 2) Testee stands in the starting position. 3) The testee's foot is assisted by the examiner to be placed in the target position. After that return to the original position. 4) After the testee feels ready, the testee is instructed to placing both the feet on the target with the sound "tut" signal stepping foot one by one. 5) The test was carried out four times (right, left, front, back) with three repetitions. 6) The test with a time limit of 10 seconds per repetition

We carried out a field trial to test the reliability of the developed instrument. The reliability test was carried out by test retest using the designed instrument. Each testee was given the opportunity to try 4 times with 3 repetitions. In the reliability test, the researcher examined the relationship/correlation between the test retests using the correlation test. Cronbach's alpha > 0.60 indicates that the test is reliable and has a strong relationship.

Table 3 showed the differences in the performance of the kinesthetic perception of the blind in the test-retest and the reliability on the kinesthetic perception test- retest using 50 total blind people. The test average was 5.38±1.52, while the retest was 6.24±1.22. The reliability is 0.816 > 0.60 so it can be stated that the kinesthetic perception test designed is consistent to measure kinesthetic perception.

Table 3. Correlation Test Results

Trial	Mean	SD	r
Test	5.38	1.52	0.816
Retest	6.24	1.22	

Then we obtained the final product: a valid and reliable kinesthetic perception test to assess the kinesthetic perception of the blind people. The research results showed that, based on expert judgment and field trials, this instrument is valid and reliable and can be used to assess the kinesthetic perception of the blind people. Figure 2 describes the final test.

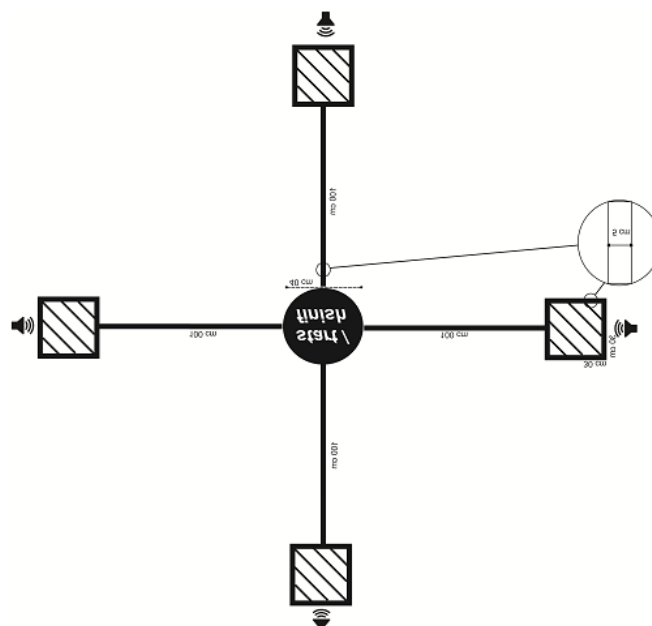


Figure 2. Kinesthetic Perception Test

The final instructions of the test are the following:

1) Implementation Instructions:

- a) Targets are placed at a distance of 100 cm to the right, left, front, and back. The target is a box with a thickness of 5 cm.
- b) Testee stands in the starting position.
- c) The testee's foot is assisted by the examiner to be placed in the target position. After that return to the original position.
- d) After the testee feels ready, the testee is instructed to placing both the feet position on the target with the signal "tut" sound stepping foot one by one.
- e) The test was carried out four times (right, left, front, back) with three repetitions.
- f) The test has a time limit of 10 seconds per repetition.

- 2) The assessment is carried out by the number of testee's foot entering the target box. 1 point is awarded if the testee's foot enters the target box, while 0 points if the testee's foot fails/does not enter the target box.

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5. DISCUSSION

Kinesthetic sensitivity allows blind people to walk and interpret their environment accurately. Previous research suggested that the Virtually Enhanced Senses (VES) System is based on ARCore, a mixed-reality system intended to assist visually impaired individuals navigate. Preliminary experiments have been carried out, which demonstrate basic orientation and mobility skills after six minutes of practice (Real & Araujo, 2020).

This study designed and tested the validity and reliability of a kinesthetic perception test instrument for the blind people, which was designed with audio, in contrast to previous studies that developed digital audio kinesthetic devices and allow direct sound manipulation without translation (Tanaka & Parkinson, 2016).

Our statistical calculations aimed at proving the reliability of the research instrument presented, as suggested by Žukauskas, Vveinhardt, & Andriukaitienė (2018). Our expert panel evaluated the validity of the instrument content, in accordance with the recommendations of Tsang, Royse, & Terkawi (2017). The results showed that the test performance was based on expert judgment. On average, the items assessed by the experts stated that this test was valid but

needed to be revised in the touching section. This is because the activity of feeling the position involved elements such as muscles, nerves, and the brain, because the touch between the feet and the object is transmitted by the nerves to the brain as information.

For some people, vision plays an important role in getting information from the environment, while blind people in obtaining information depend on other senses such as hearing, touch, smell, and kinesthetic perception. This sense is useful for blind people to understand an object beyond the range of vision. This designed test is a test that relies on the senses of hearing and touch, which produces kinesthetic perception. Hearing provides clues about the direction and distance of an object with sound. Through touch, the blind people are able to recognize the shape, position, size, and surface differences, so that they can provide an image in their minds. Touching can be interpreted to touch and feel. The designed test was required the testees to move their bodies and feel the appropriate position with voice prompts. The feeling activity of the position involves cognitive abilities because it is related to the perception of what is being touched.

The results of the test-retest showed a strong relationship between test and retest, where there is not difference in performance in different tests and retests. This proves that the kinesthetic perception test-retest is consistent/reliable in measuring the kinesthetic perception of the blind people. Hearing and touch abilities for the blind people are one of the verification tools. Test-retest reliability is a measurement theory concept that measures the stability of a measure in repeatability of measurements (Noble, Scheinost, & Constable, 2021). We can compare our results with a study that developed a visual kinesthetic navigation device for the blind people, which was simulated with various types of obstacles. In this study, the first day of obstacle detection was the worst because they were not familiar with the new concept of environmental perception and vibration intensity scale, with the testee feeling insecure and taking small and slow steps (Stopar, 2020).

6. CONCLUSION

This kinesthetic perception test has proven to be a valid and reliable assessment method. This kinesthetic perception test can be used as a research tool to assess the kinesthetic perception of blind people and to classify blind people according to their different kinesthetic perceptual abilities.

7. REFERENCES

1. Abdul Karim, K. A. (2020). The challenges faced by visual impairments in buying clothes and how to wear clothes. *Ideology Journal*, 5(2), 73–78.
2. Alcaraz Martínez, R., Turró, M. R., & Granollers Saltiveri, T. (2022). Methodology for heuristic evaluation of the accessibility of statistical charts for people with low vision and color vision deficiency. *Universal Access in the Information Society*, 21(4), 863–894.
3. Ali, H. S., & Saleh, S. (2021). The Accuracy of Serving Direct from the Top and its Relationship with the Sensorimotor Perception of Young People for the Volleyball Al-Sinaa Sport Club Team. *Annals of the Romanian Society for Cell Biology*, 25(6), 11137–11143.
4. Atteng, C. J. (2021). Social inclusion as a task in the developmental process of persons with visual impairment: implication for special needs counselling. *European Journal of Public Health Studies*, 4(1), 22–36. <https://doi.org/10.46827/ejphs.v4i1.86>
5. Castro, K. J. S., Salomão, R. C., Feitosa Jr, N. Q., Henriques, L. D., Kleiner, A. F. R., Belgamo, A., ... Souza, G. S. (2021). Changes in plantar load distribution in legally blind subjects. *PloS One*, 16(4), e0249467.
6. Gall, M. D. (2010). *Applying Educational Research: How To Read, Do, and Use Research to Solve Problems of Practice*. Pearson.
7. Łacka, I., & Brzezicki, Ł. (2021). Efficiency of the research and development activities of technical universities in Poland. *Social Inequalities and Economic Growth*, 63(3), 258–274.
8. Latash, M. L. (2021). Production and perception of intentional and unintentional actions. *Journal of Human Kinetics*, 76(1), 51–66.
9. Likova, L. T., Mei, M., Mineff, K. N., & Nicholas, S. C. (2019). Learning face perception without vision: Rebound learning effect and hemispheric differences in congenital vs late-onset blindness. *Electronic Imaging*, 2019(12), 231–237.
10. Marelli, S., Castelnuovo, A., Somma, A., Castronovo, V., Mombelli, S., Bottoni, D., ... Ferini-Strambi, L. (2021). Impact of COVID-19 lockdown on sleep quality in university students and administration staff. *Journal of Neurology*, 268(1), 8–15.
11. Meléndez-Jara, C. M., Ramírez-Sáenz, N. L., & Tafur-Mendoza, A. A. (2021). Parental Competencies in Mothers of Infants with Disabilities and their Relationship to Adaptive Behavior and Motor Development. *International Journal of Early Childhood Special Education*, 13(1), 121-131.
12. Misko, A. L., Weinstock, L. D., Sankar, S. B., Furness, A., Grishchuk, Y., & Wood, L. B. (2022). Peripheral Inflammatory Cytokine Signature Mirrors Motor Deficits in Mucopolidosis IV. *Cells*, 11(3), 546.
13. Noble, S., Scheinost, D., & Constable, R. T. (2021). A guide to the measurement and interpretation of fMRI test-retest reliability. *Current Opinion in Behavioral Sciences*, 40, 27–32.
14. Real, S., & Araujo, A. (2020). VES: A mixed-reality system to assist multisensory spatial perception and cognition for blind and visually impaired people. *Applied Sciences*, 10(2), 523.
15. Sigrist, R., Rauter, G., Riener, R., & Wolf, P. (2013). Augmented visual, auditory, haptic, and multimodal feedback in motor learning: a review. *Psychonomic Bulletin & Review*, 20(1), 21–53.
16. Stopar, K. (2020). Device for visual kinesthetic navigation of the blind and visually impaired. *2020 IEEE 20th Mediterranean Electrotechnical Conference (MELECON)*, 646–651.
17. Tanaka, A., & Parkinson, A. (2016). Haptic wave: A cross-modal interface for visually impaired audio producers. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 2150–2161.
18. Tsang, S., Royse, C. F., & Terkawi, A. S. (2017). Guidelines for developing, translating, and

- validating a questionnaire in perioperative and pain medicine. *Saudi Journal of Anaesthesia*, 11(5), 80.
19. Van der Ham, A. J., Van der Aa, H. P. A., Brunes, A., Heir, T., de Vries, R., Van Rens, G. H. M. B., & Van Nispen, R. M. A. (2021). The development of posttraumatic stress disorder in individuals with visual impairment: A systematic search and review. *Ophthalmic and Physiological Optics*, 41(2), 331–341.
 20. Žukauskas, P., Vveinhardt, J., & Andriukaitienė, R. (2018). Structure of Research Design: Expert Evaluation. In *Management Culture and Corporate Social Responsibility*. IntechOpen.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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