WALKING PATTERN OF SIGHTED VOLUNTEERS WITH OPEN EYE AND CLOSED EYE CONDITIONS

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ABSTRACT

Introduction: A blind person is likely to veer from the straight line during walking. A higher degree of veering can sometimes result in accident or injury in both indoor and outdoor conditions. Hence, it is important to know the degree of veering that may happen in case of a sighted individual become blind due to the loss of vision.

Methods: The present study was conducted on thirty (30) volunteers who walked with open and closed eyes, in a grid-marked area of 17m by 10m space at their comfortable pace. The blind volunteers were instructed to walk in a straight line from a central starting point of a space marked in a grid of 1 meter. Each subject underwent three trials. The walking path of the volunteer was marked using a pair of sponge absorbed with three different pigment colors.

Results: All volunteers had walked in a straight line in the open eye condition but had a varied degree of veering in the closed eye state. The stepping style of the volunteers indicated that 53% volunteers took left leg forward as the first step in open eyes while in closed eyes conditions, it was 50%. The numbers of steps taken in the open eye condition compared to the closed eye one were 24.65 ±1.97 and 29.40 ±4.43 respectively. Similarly, distances walked in these steps were 16.57m ±0.27m and 16.37m ± 1.04m. It is possible that the closed eye condition leads to larger variation in the number of steps and distance covered due to cautious stepping. That might lead to veering also.

Conclusion: Absence of the visual cues can contribute to significant deviation from the intended path of walking. Repetition possibly increases the degree of adherence to the desired path in blindfolded walking. Foot dominance is possibly not related to the direction of veering.

Key Words: Closed eye, Open eye, Veering.

INTRODUCTION

The visual cue is an important aspect for any kind of motion by a human being. In case of blindness, this support is not available. Generally, any person can walk in a straight line with the help of visual cue. But when they are blind, they veer from the straight line. While walking on a footpath, a blind pedestrian is likely to get injured or meet accident (1) because of a higher degree of veering. It may result in accident or injury even during indoor activities. It has been observed that meandering occurs in the desert, under dense fog and also in the unfamiliar spaces due to lack of identifiable marks or predictable sound and spatial perceptions (2-6). There is also enough evidence that adults and children can keep track of their position during blind locomotion after viewing the target location prior to being blindfolded (7-10). The initial opinion was that veering happens as a result of a biologically useful innate spiraling mechanism that returns a lost human being or animal to its starting point. This view was based on reports that animals, including man, move in circles when they are lost in the desert or forest (11).The assumption in this is that the degrees of veering increases with the distance and ends in the movements that eventually describe a circular path (12). Many authors had opined that a pedestrian's ability to walk in straight line depends on three factors: the availability and quality of sensory information about the walking direction; and the capacity to execute movements towards an intended direction (9, 13-14). Vestibular, proprioceptive or kinesthetic cues may be useful in detecting rotation away from a straight path (15-16). Although many studies have shown divergent results and interpretations, a common aspect in all of the studies is an impression that humans, when walking blindfolded or in environments with reduced visual cues, move in a large circle or spiral many times involuntarily (17). Analysis of the trajectories of movement in large spaces, both outdoors (18) and indoors (19), indicates that blindfolded subjects walk in circles, and rarely in a systematic direction.

The purpose of the present study was to find out the walking pattern for sighted volunteers with the open eye (OEC) and closed eye conditions (CEC) while the space of walking is limited.

METHODOLOGY

Participants

This study included thirty volunteers aged in the range of 18-30 years who had no known impairment in the sensory or musculoskeletal system. The volunteers were of mean age 23.8 ± 5.9 years. Their height and weight were 166.9 ± 6.1 cm and 59.8 ± 8.2 kg. All the volunteers were right hand dominant and 28 of them were found to be right leg dominant.

Equipment

The study was performed during the daytime on a level surface of size 17m x 10m. Grid lines were marked on the surface as a 1m x 1m square (Fig. 1) for manual measurement of the distances. The distance was measured by using a measuring tape. During the experiment, the volunteers were blindfolded by wearing a non-transparent cloth that completely occluded their central and peripheral vision.

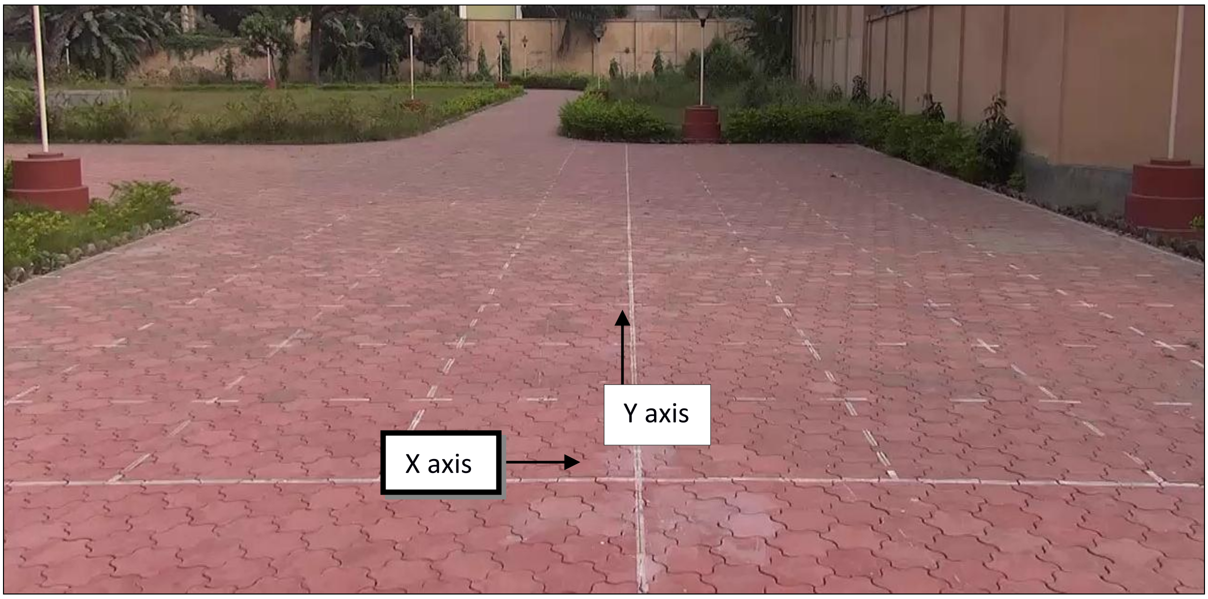

Fig. 1: Grid marked experimental area (each box is 1m x1m).

Design of the Study

Experimental design was followed in this study. Each volunteer was guided to the experimental space and given proper instructions prior to the experiment. The volunteers underwent a series of practice trials, without feedback, to get used to both the equipment and the task.

At the beginning of each trial, every volunteer was told to stand at the starting point and then the sponge soaked in pigment color was attached on both the heels to enable clearly identifiable heel marks (20). The shoulder of the volunteer was aligned to the baseline. In both OEC and CEC, the hands of the volunteer were raised in the front direction so as to help them as the guide to the path. Then, they were told to walk at their comfortable pace till the end of the line. Each candidate performed three trials with a rest pause of 2 minutes between each trial.

During the experiment, volunteers first walked with eye open and then they were blindfolded with nontransparent thick cloth (eye closed). Each volunteer walked with an open and closed eye for three times. Volunteers were asked to write on a piece of paper and their left or right-hand dominance was noted. To observe their dominant leg, they were asked to kick a soccer ball to a goal post and the left or right leg dominance was noted.

ANALYSIS OF DATA

At first, the data was treated through Anderson-Darling test to determine if they are following a normal distribution. It was observed that none of the data set followed a normal distribution, so, non-parametric tests were applied on the data sets. The data on starting foot in walking had only two options, right or left and is in binary form data. Therefore, Kendall's Tau was the suitable test to determine correlation. The data of the step number and the distance covered are continuous; hence, Spearman's Rank Correlation was performed. The results were considered statistically significant at the level of $p < 0.05$ (p = probability for the significance of correlation). Kendall's Tau and Spearman's Rank Correlation were calculated using OpenStat software, while Anderson-Darling tests, descriptive statistics, and Box plot were done using the Gnumeric software.

RESULTS

The number of steps taken to cover the stipulated distance varied in different trials (Fig. 2). The range of data was small in OEC while that of CEC had a larger range of change. StpBTr1 appears to have the largest variability than the other trials in the CEC or OEC. The distribution was skewed towards the lower side of the range in all trials of OEC. Skewness was toward the upper side of the range in CEC except for the first trial. One outlier point in the trial two and four outliers in the trial three of CEC were observed.

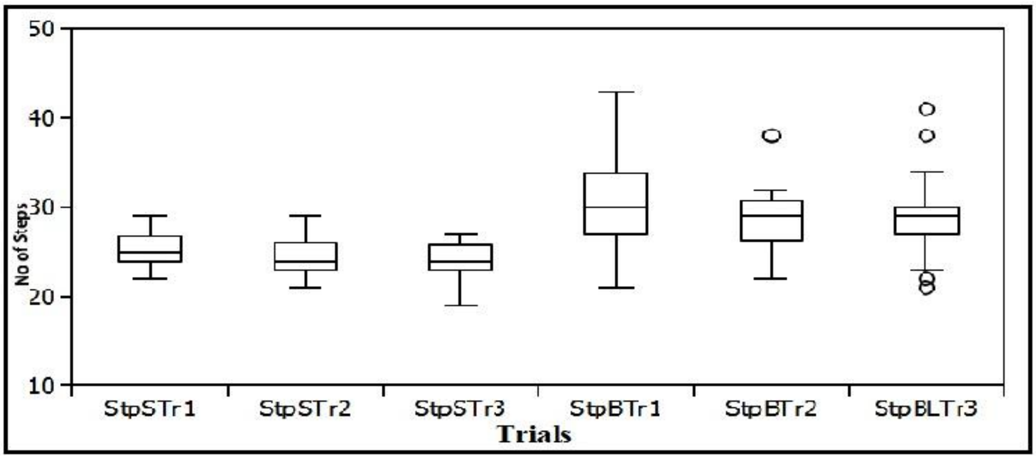

Fig. 2: The box-plot number of steps taken in the open eye and closed eye condition. (StpSTr indicates number of steps by sighted volunteers StpBTr indicates number of steps by blindfolded volunteers.)

Distances covered by the volunteers are shown in Fig. 3. First two trials in OEC show very small variation and skewness were observed in the distance covered, while the third trial had more variation. In the CEC the range of data decreased with the number of trials. OEC trials had two outliers whereas CEC had nine outliers.

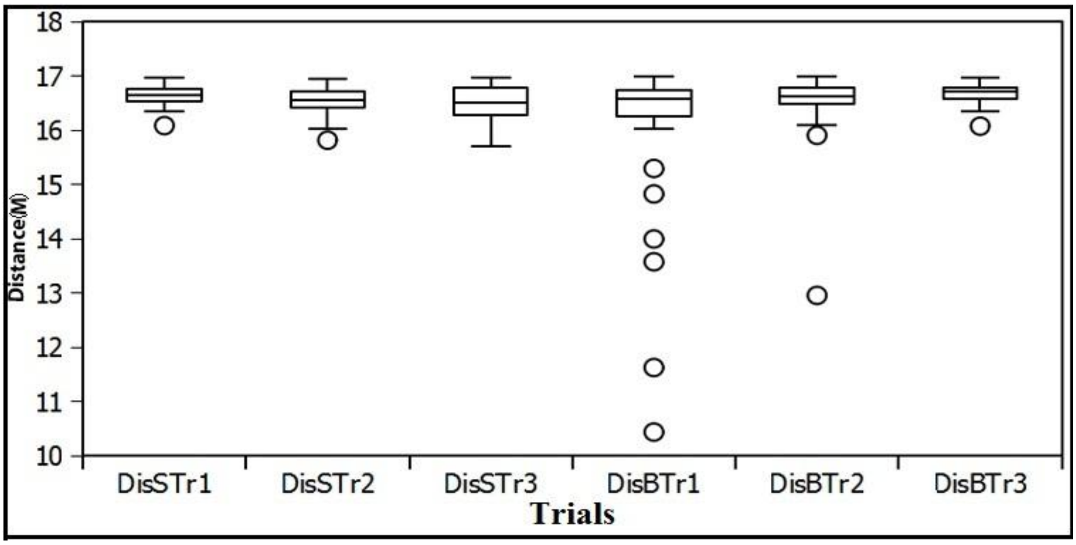

Fig. 3: Box-plot of distances covered in the eye and closed eye condition (DisSTr indicates distance covered by sighted volunteers, DisBTr indicates distance covered by blindfolded volunteers)

The correlation values between the trials in OEC and CEC of step number and distance covered were calculated. All the correlations were found to be significant. The correlation between trial 2 & 3 was found to be higher. However, distance covered in different trials had a different picture. Except for the correlation between trial 2 and 3, for both OEC and CEC, none were significant. Kendal's Tau was calculated to find out if the starting foot and the direction of veering bear any relationship. None of the correlation, for OEC & CEC for starting foot and direction of the walk, was found significant.

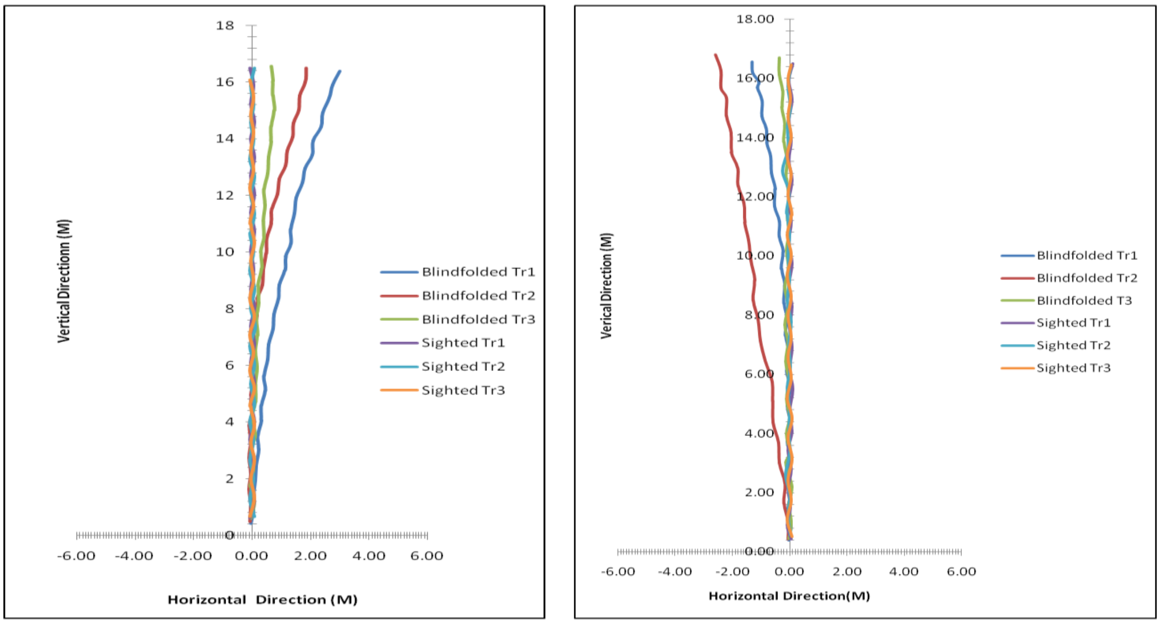

Fig.4: Example of trajectories during walking: 4A represents the turn towards the right side, 4B represents the turn towards the left side.

Trajectories of walking in the OEC and CEC are shown in Fig. 4. As seen in the figure, the volunteers in OEC walked in a straight line and in the CEC, they veered in different directions. Two main types of veering were observed: veering to the right side and the left side of the walking direction. The example where the volunteers walked towards to the left side is given in 4A and that of walking towards the right side is shown in 4B along with the open eye path for each. Maintaining the conventional system, the scaling in X-axis (to depict the sidewise movement of the volunteer) has an indication as a positive sign to the right side of the body and negative sign indicating left side of the body. The Y-axis denotes forward movement direction and scaled accordingly. It can be seen that the path of walking is not same in each trials, the curvature has varied from trial to trial. It was observed that 53% and 50% of the volunteers started with left foot forward in the OEC and CEC respectively while covering 17m distance.

DISCUSSION

A general observation in the present study indicates large individual variation in the walking path and distance covered when the visual cue is not present (Fig. 2 & 3). Presence of outliers in a number of steps of CEC is an indicator of the cautious behavior of some of the subjects in the absence of visual cue (Fig. 2) (21). It seems that some of the subjects had taken a number of steps and a few had taken less number of steps. In case of distance traveled, many outliers were identified and all of them were on the lower side of the boxes, meaning shorter distances traveled by them. In the present study, the distance traveled was estimated from the vertical distance (distance in the Y-axis) of the point where the person stopped. So, a shorter distance indicates the sidewise deviation of the person from the desired direction of the walk. This is only possible if the path of walking is curved. The trajectories of walking shown are Fig. 4 (A & B) prove this argument.

Since the walking space in the present experiment was smaller (17m), the nature of curvature in longer distance of blindfolded walking could not be ascertained. A number of previous studies (18-20, 22-23) have indicated that human being has a tendency to walk in a circular path if the visual input is not available. Many of these studies have taken a larger walking area or distance (100m in some cases). It is possible that had the distance of walking been larger, the circular path might become evident. One aspect is clear in the present study that practice may lead to better adherence to the straight path or diameter of the circular path is increased if the person walks in the same area repeatedly. Significant and the higher correlation coefficient between trial 2 & 3 in both the step number and distance covered add more strength to the above view. In the present study, each trial of walking was preceded by visual inspection of the path. So some sort of mental imagery is possible that would have supported in the reduction of the deviation from the straight line in subsequent trails.

In the present study, starting foot of 53% respondents was the left foot in the OEC and similarly, 50% in case of CEC. Non-significant Kendall's Tau values for the relationship among trials means that foot dominance does not influence the choice of foot in the first step rather it followed simple probability.

CONCLUSION

The present study forwards the following inferences:

- Veering for sighted people in open eye and closed eye conditions was studied.
- Absence of the visual cues can contribute to significant deviation from the intended path of walking.
- Repetition possibly increases the degree of adherence to the desired path in blindfolded walking.
- Foot dominance is possibly not related to the direction of veering.

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