A Preliminary Study of Walking Bias Phenomenon Which is Related to Ring-Wandering

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In the present study several experiments of walking bias were performed in order to investigate the fundamental nature of ring-wandering and to examine the relationships between various physical dominant factors and the direction of walking bias. Subjects were 20 to 29 male and female college students, 18 to 21 years in age.

The conclusions of the present study were summarized as follows:

- 1) The repeatability of one's direction of bias was rather high if the experimental conditions were the same for all walkings.
- 2) Assuming that 5 m from the center line is the limit of acceptable deviation, the distance one can keep correct direction to the target while blindfolded would be roughly 40 m.
- 3) The relationships between walking speed and amount of walking bias were as follows: for the whole group, the subjects who walked unconsciously with high speed showed relatively smaller bias; and with respect to an individual subject when he walked with consciously high speed, he tended to register smaller walking bias than he had registered previously in walking unconsciously.
- 4) There were no significant relationships between one's direction of walking bias and his various physical dominant factors.

Key words: Ring-wandering, Walking bias

INTRODUCTION

When a mountaineer is deprived of a visual framework in the deep mountains or in some other comparable cases, he may fall into a situation in which he keeps going around and around in the same area, while believing himself to be going straight to a destination.

Such a phenomenon is called ring-wandering (Iwata, 1971). Ring-wandering tends to occur in conditions of thick fog or blizzard in flat areas with little topographical variation, or in a forest having no open field of vision (Fujiki, 1934; Kawasaki, 1975).

The ring-wandering phenomenon sometimes is connected with unfortunate accidents. The accidents of Katsunori Itakura and his group at

"Amidagahara" in the Tateyama mountains in 1923 (Fujiki, 1934), which is a well known case in the history of mountain climbing in Japan, and the tragedy of the Alpine Club of Aichi University at Mt. Yakushi in 1968 (Honda, 1977) are two examples attributed to situations which resembled ring-wandering in a blizzard.

Several studies (Hoshino, 1979, 1980, 1981; Yamamoto, 1971, 1972, 1974; Yasuda, 1970) of walking bias phenomenon have been reported in which deviations from a straight line were observed when subjects were asked to walk with their eyes blindfolded.

However, all these studies used only very short distances of walking, ranging from 10 to 30 meters in the experiments and their quantities of bias were

very small, ranging from a few centimeters to a few meters. These studies, therefore, should be considered to have been dealing with a different phenomenon from ring-wandering.

While an exact experimental simulation of ring-wandering is virtually impossible, it was believed that some of the fundamental nature of ring-wandering might be explored in an experiment of walking bias in which the walking distance was extended up to 100 meters in outdoor conditions, on level ground. In the present study experiments of walking bias phenomenon were performed in order to investigate the fundamental nature of ring-wandering. Furthermore the relationships between various physical dominant factors (e.g. right-handedness etc.) and the direction of bias were investigated.

METHODS

Subjects

Subjects were 20 to 29 male and female college students, 18 to 21 years in age. The number of subjects varied somewhat for each experiment.

Experiments

(A) About walking bias phenomenon

(1) Fundamental experiment

At first the subject was asked to look at the target set 100 meters ahead, and then he was asked to start toward that target blindfolded. The tester measured the distance of deviation from the center line at each 10 meter point on that line (Fig. 1-A). When the subject reached the target line (100 m from the start line, Fig. 1-B), or his walking deviation was more than 90 degrees from the center line (Fig. 1-C, i.e. he was no longer walking toward the target direction),

Fig. 1 Measurement of the walking bias

he was stopped. The distance of his advance from the start as measured parallel to the center line was called "the final distance". After the subject was stopped, he was taken by an assistant to the starting point through a zigzag walk keeping the blindfold on, so that he was kept from any information as to his deviation.

(2) Effect of preliminary walking

The subject was asked to walk starting 5 m behind the starting line, watching the target set on the center of the target line (Fig. 1-D). And just when he passed the starting line, the blindfold was applied, and he kept walking toward the target.

(3) Influence of walking speed

The subject was asked to perform three trials of the fundamental experiment at different walking speeds: 1. high speed, 2. intermediate speed, 3. low speed. The order of these three trials were at random for each subject, so that there was no learning effect in this experiment.

(4) Influence of auditory cue

The subject was asked to stop when he reached the 50 m line (Fig. 1-E), and then a whistle was blown vigorously by the tester for three seconds at the target point (Fig. 1-D). The subject listened to that sound, and then he was allowed to change his walking direction to go according to the auditory cue.

(5) Effect of previous knowledge on the direction of walking bias

Each subject was informed of his direction or personal trend of walking bias after four trials of fundamental experiment. Then he was asked to perform another trial.

These five different experiments described above were performed in these order. In all experiments except No. (5), subjects were kept from any learning effect, because they could not know any result of their walkings.

(B) Effect of physical factors on lateral dominance

The physical factors which might be related to the lateral dominance of each subject were mea-

sured as follows:

- 1) Dominant arm (right or left). This was declared by each subject.
- 2) Dominant leg (right or left). This was defined as the kicking leg in running long jump.
- 3) Dominant eye (right or left). This was defined as the eye which was used in peeping into the finder of a camera.
- 4) Length of leg (right or left). The dominant side was designated when one side was more than 5 mm higher than the other in comparison of the height of the spina iliaca anterior superior.
- 5) Weight distribution dominance (right or left). The subject was asked to stand in his natural position on two weighing scales on which a footmark was drawn, and his weight was measured. The dominant side was designated when one side was more than 1 kg heavier than the other.
- 6) Blindfold balance dominance (right or left). The duration for which a subject was able to maintain balance on one foot while blindfolded was measured three times for each foot. The dominant side was designated when the average time of three trials on one side was more than 10 sec longer than the other.
- 7) Inclination of the shoulders (right or left). Subjects were photographed from their back in front of a grided wall. Inclination of their shoulders was evaluated by drawing a line on the print. "Right" means an inclination where the right shoulder was lower than the left shoulder.

RESULTS AND DISCUSSION

1. Repeatability of one's direction of bias

Each subject performed three trials of fundamental walking while blindfolded and then once more with the addition of preliminary walking ($N=23$). These four trials were performed over two days (twice a day), as such procedures were quite time consuming. Due to factors beyond control, the experimental conditions on these two days: the direction of wind, the noise of surroundings and the

ambient temperature were not quite comparable.

The direction of walking bias agreed three times out of four trials in 86.4% of the subjects. Some 77% of the subjects demonstrated a walking bias in the same direction in both of the two trials performed on the same day. χ^2 test revealed that these two results showed an occurrence of statistical significance with 1% of confidence ($\chi^2=11.60$ and 6.54 $df=1$ $P<0.01$). However, the percent of subjects who demonstrated a walking bias in the same direction in all the four walkings was not so large: 59.1%. The difference in experimental conditions between the two days may be responsible for this result at least to some extent. Namely, on one test day, voices and sounds of cheering for a soccer game on a nearby field were audible, whereas almost no sound was heard on the other day. Such auditory cues may quite conceivably have influenced the direction of bias. Indeed some subjects reported that at first the cheering for the game was a good cue to know the direction of the target. However, they added that it became a distractive factor as the fluctuations in the volume, and site of such voices and sounds were quite confusing. In this connection, on the day having no cheering voice, 90.1% of the subjects demonstrated a walking bias in the same direction, but on the day having many noises only 63.6% of the subjects revealed the same direction.

Judging from these results it was speculated that if the experimental conditions such as direction of winds and ambient temperature have been the same,

and if there were not so many noises for all four walkings, the direction of walking bias would have agreed more than three times out of four trials. Therefore, it was suggested that the repeatability of one's direction of bias was rather high.

2. General direction of walking bias

All subjects except one performed 3 trials of fundamental experiment and 1 trial of that added preliminary walking. And for some reasons one subject could perform only 3 trials. Therefore, 23 subjects performed 91 trials in all. From the results, the 91 trials were divided into three categories as follows:

- 1) Turning to the right: 46 instance (50.5%).
- 2) Turning to the left: 38 instance (41.8%).
- 3) Others: 7 instance (7.7%) (table 1).

The type of turning right exceeded those of turning left by about 10%. Several other studies (Hoshino, 1979, 1980; Yasuda and Udamura, 1970) have also revealed that turning right exceeded turning left, but they showed that it occurred at a higher rate (i.e. about 70~75% of the cases showed turning right) than the present study. It is considered that this difference was attributable to the disparity of experimental conditions. It should be noted that while former studies (Hoshino, 1979, 1980, 1981; Yamamoto, 1971, 1972, 1974; Yasuda and Udamura, 1970) usually employed from 10 to 30 m of walking distance at most, the present study introduced 100 m of target distance, for the purpose of studying ring-wandering. In the present study there were several cases in which the subject at first turned to the right

Table 1 Directions of walking bias in all 91 trials.

Direction of bias	R	L	L-R	R-L	S	Total
Number	46	38	3	1	3	91
%	50.5	41.8	3.3	1.1	3.3	100

R: turn to right.

L: turn to left.

LR: At first turn to left but later turn to right.

RL: At first turn to right but later turn to left.

S: Almost straight to the target. (cases in which the amount of bias was less than 2.5m from the center line.)

a little, but later turned to the left greatly. Consequently, it is suggested that results of this study and those of former studies cannot be compared directly. And it was concluded that there were no statistically significant differences between left and right in respect to one's dominant direction of bias (table 2).

Judging from these results, it was speculated that the percent of subjects turning to the right and of those turning to the left was almost the same from the standpoint of ring-wandering.

3. The distance that one can walk to the target keeping within a limited amount of bias from the center line.

The distance of advance that all subjects made keeping within a limit of 5 m of bias from the center line was 39.9 m in average (SD=22.34) (table 3). Therefore assuming that 5 m from the center line is

Table 2 Dominant directions of walking bias in each subject.

Directions of bias	R	L	M	Total
Number	9	9	4	22
%	41	41	18	100

R : Subject who turned to right more than three times out of four trials.

L : Subject who turned to left more than three times out of four trials.

M : The other cases.

the limit of acceptable deviation (considering that a man walked on a path of 5 m in width), it was suggested that the distance one can keep a correct direction toward the target while blindfolded would be roughly 40 m, although the standard deviation was considerably large. And the final distance was 69.8 m in average. Therefore, it seems reasonable to suggest that when one is deprived of a visual framework by deep fog or blizzard in mountains, the distance he could keep correct direction would be roughly 40 m not using a compass. And if he walked 100 m in that condition, he would probably walk in an absurd direction.

4. The relationships between walking speed and amount of walking bias

According to walking speed, 9 subjects were picked out as being in the fast walking group (average speed : 1.3 m/s), and also 9 subjects were chosen as being in the slow walking group (average speed : 0.9 m/s) from all 29 subjects. Amounts of walking bias of these two groups were compared. Mean final distance of the fast walking group was superior to that of the slow walking group by about 20 m. However, since their SDs were quite large, there was not statistical significant difference by t test (table 4).

In addition 20 subjects were asked to perform three trials of fundamental experiment with three different walking speeds (1. high speed : 1.9 m/s in

Table 3 The distances that one can walk to the target keeping within a limited amount of bias from the center line.

Amount of bias	Experiments	N	$\bar{X}$ (m)	SD(m)	t
2.5m from the center line	FE	68	33.0	21.17	0.52
	APW	23	35.7	18.85	
5m from the center line	FE	68	39.9	21.43	1.13
	APW	23	46.1	23.45	
10m from the center line	FE	68	49.2	23.20	1.88
	APW	23	60.0	25.67	
The final distance	FE	68	69.8	26.32	1.23
	APW	23	77.5	23.63	

FE : Fundamental experiment.

APW : Fundamental experiment with 5m of preliminary walking added.

Table 4 Comparison of fast walking group and slow walking group in amounts of walking bias.

	Walking speed		Final distance#		t
	$\bar{X}$ (m/s)	SD(m/s)	$\bar{X}$ (m)	SD(m)	
Fast walking group(N=9)	1.3	0.13	68.9	25.14	1.61
Slow walking group(N=9)	0.9	0.07	46.7	30.55	

: Final distance means that the distance one walked from the start line before his walking direction became more than 90 degrees from the center line. This distance was measured parallel to the center line (see Fig. 1-c).

Table 5 Comparison of amounts of bias between fundamental walking and walking given auditory cues.

	N	Final distance		t	5m from the center line #		t
		$\bar{X}$ (m)	SD(m)		$\bar{X}$ (m)	SD(m)	
FW	23	69.8	26.32	4.50**	39.9	22.43	2.30**
AW	23	96.5	9.14		56.1	30.18	

** : $P < 0.01$

* : $P < 0.05$

: Distanced one walked from the starting line before his walking bias became more than 5m.

FW : Fundamental walking.

AW : Walking given the auditory cues.

average, 2. intermediate speed : 1.1 m/s in average, 3. low speed : 0.7 m/s in average), and amounts of these three walking biases were compared. Sixteen (80%) of these 20 subjects showed the longest final distance when they walked consciously with high speed. χ^2 test showed that this tendency was statistical significant value ($\chi^2 = 19.45$ df=2 $P < 0.01$). Only 2 subjects showed the longest final distance when they walked with consciously intermediate speed, and also 2 subjects showed that result with low speed. Therefore, it was concluded that a blindfolded person who walked with high speed; whether consciously or unconsciously, could advance in a relatively straighter direction than one who walked slowly. It was considered that the reason for such results was that the longer one's walking time, the more possibility he had to be influenced by mental factors or by any other biases.

5. Influence of auditory cue

Fifteen (65.2%) out of 23 subjects revealed cor-

recting activity of their walking bias after hearing the auditory cue. This figure 65.2% was not significant in the statistics by χ^2 test ($\chi^2 = 2.13$ df=1). This result suggested that when a man was deprived of a visual framework in walking, the auditory cue of a single whistle blow was not necessarily a helpful aid to him to decide the walking direction.

However, when the whistle was blown, 5 out of 8 subjects who didn't reveal a correcting activity had very small bias of less than 5 m. Therefore, it was considered that they heard the sound almost in a frontal direction, and consequently they didn't reveal any correcting activity. In final distance the average of all subjects using auditory cue was 96.5 m. This value was significantly higher than that of the fundamental walking (69.8 m in average) by t test (table 5).

Judging from these results, it was speculated that the auditory cue was not necessarily a helpful aid to the subjects to decide the walking direction. How-

ever when one's walking bias was exceedingly large, the auditory cue could be an effective aid for him. But in the mountains or other outdoor places, it is expected that winds or geographical features would much influence the sound itself. Therefore, in the deep mountains it will be difficult for one to decide the right direction to the target by a single shot auditory cue.

6. Effect of previous knowledge on the walking bias

After being informed of his personal trend of walking, each subject was asked to perform another trial of fundamental experiment. Consequently 15 out of 21 subjects (71.4%) revealed their walking bias in reverse ($\chi^2=3.85$ df=1 $P<0.05$). This result suggested that many subjects walked intentionally in a reverse direction of their personal trend, and that mental process greatly influenced them in walking blindfolded.

7. Relationships between one's direction of bias

and various physical dominant factors.

Under the hypothesis that walking bias is influenced by some physical dominant factors (e.g. right-handedness etc.), the relationships between these factors and the direction of bias were investigated (table 6). No significant relationships were obtained by χ^2 test.

This result indicated that there were no obvious relationships, such as a right-handed person would turn to the right, or one who had a longer right leg than his left would turn to the left and so on. However, the 22 subjects in this experiment were considered rather few, and therefore this experiment should be repeated with more subjects.

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Table 6 Relationships between one's direction of walking bias and various physical factors of lateral dominance.

		N	TR	TL	Mixed	Total	χ^2
Dominant arm	Right	22	7	7	4	18	1.12
	Left		2	2	0	4	
Dominant Leg	Right	22	4	6	2	12	4.28
	Left		5	3	2	10	
Dominant eye	Right	22	5	7	4	16	2.79
	Left		4	2	0	6	
Length of legs	Right	22	0	1	2	3	4.50
	Left		5	6	1	12	
	No diff.		4	2	1	7	
Weight distribution dominance	Right	22	7	8	3	18	2.75
	Left		5	6	1	2	
	No diff.		1	0	1	2	
Blindfold balance dominance	Right	22	4	4	1	9	2.32
	Left		5	4	3	12	
	No diff.		0	1	0	1	
Inclination the shoulders	Right	22	4	5	1	10	2.77
	Left		2	3	1	6	
	No diff.		3	1	2	6	

TR : Turning right more than 3 times out of 4 trials (N=9).

TL : Turning Left more than 3 times out of 4 trials (N=9).

Mixed : The other cases described above (N=4).

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