American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-8, pp-127-137
www.ajer.org
Research Paper Open Access

Research on Influence of Speed and Interval on aBlind Illusion

Yining Tong[1],Hiroyoshi Todo[2], Jian Sun[1], Xiaoxiao Qian[1]
[1](*Faculty of Engineering, University of Toyama, Japan)*
[2](*Wicresoft Japan Inc., Japan)*
Corresponding Author: Yining Tong

ABSTRACT: *Illusion research always focused on observation of phenomena and classification of characteristics. Therefore, we need to further pursue the factors which cause and affect illusion. In this paper, for the research of Blind Illusion (BI), we propose a novel method of quantitative measurement and simulate a large number of scenes on the computer using the software developed by our team. We study the effects of two factors, the falling speed of snowflakes and the interval width of blind strips, on BI respectively. We simulated phenomena of different falling speeds and different intervals of blind strips to test the people taking part in our experiments, collected all the data. We analyze the factors working on BI and their effect on quantity in order to find out some reasons leading to BI and summarize their working rules. We hope to speculate human perception system further through finding out the mechanism of illusion.*

KEYWORDS *-Blind Illusion (BI), quantitative measurement, falling speed of snowflakes, interval width of blind strips, scene simulate*

Date of Submission: 27-07-2018 Date of acceptance: 11-08-2018

I. INTRODUCTION

When people observes an object, he is often perceived. The object that he feels is not what it actually is. It has many reasons, such that an object show different colors in different light, an object appears different shapes from different directions, there are different physical and psychological states in different observers, and so on. This is an illusion which is ubiquitous. An illusion on vision is called optical illusion and the one on hearing is called auditory hallucination. The mechanism of optical illusion has always been a hotspot in many subjects, especially in psychology and physiology. Most of research in the field of psychology focus on the optical illusion associated with perceptual process, while research in the field of physiology focus on physiological mechanisms of optical illusion, such as eye movement theory and nerve displacement theory. Research in psychophysics mainly analyzes structures of geometric shapes which often cause optical illusion, and describes the optical illusion on quantity in order to find some rules and patterns.

Phenomena of optical illusion have been paid attention to for a long history in psychology. Oppel (1855)is the first person who study them deeply, followed by many famous psychologists [1-2]. More importantly, they broaden the research scope of optical illusion. At present there are many theories in psychological to explain phenomena of optical illusion, such as Gestalt theory, Ecological Vision theory, Constructivism, Brightness Contrast hypothesis, Vision theory, Misuse theory, Abnormal misuse theory, Apriorism, Empiricism, and so on. But none of them can fit for all optical illusions well. There are also many theories in physiology, such as Lateral Inhibition Neural Network, Eye Movement theory, Three-Component theory, Three-Link theory, Relative Processing theory of Color Perception and so on. Although the above theories are supported by the data from neural and physiological experiments, they are need further improvement [3-10].

One of many important purposes of research is to elucidate perceptual characteristics of human beings. The study on optical illusion is one of a few methods known as far through which people can explore effectively the analysis mechanism of the brain [11]. In psychophysics, optical illusion is expected to make up for the lack of contact between psychology and physiology. Furthermore, it can help people know about eye movements mechanism in visual system, then understand the structure of brain and how the brain processes visual information. An illusion is a distortion of an objective thing under certain conditions [12]. It is not a pathological phenomenon. Many researchers believe that the brain neglects part of all the information sometimes when it faces too huge information to accept and conduct in time, which leads to illusion.

The other important purpose is how to use the optical illusion effectively. For examples, trompe l'oeil which is often found around us is designed to make use of optical illusion to form the effect of art, while the construction of the Parthenon temple utilizes a large number of parallax corrections to reduce illusion, and parallax correction has also been applied to avoid traffic accidents [13]. In the future things can be developed in ideal directions by applying theories of optical illusion.

The occurrence of optical illusion is not immutable, and it has a great relationship with some characteristics of an observer [14]. Observers with different amounts of observation experience in optical illusion can make different judgements in the face of the same optical phenomenon [15], and observers with different occupations may have different optical tendencies [16]. Therefore it is necessary to choose the same kind of observers as a test group in order to acquire objective conclusions in optical illusion experiments. Japanese scholars Ichikawa et al. studied the factors affecting optical illusion on observation quantity over and over again [17]. They divided all the participants into two teams: trained and untrained, then tested them about three aspects of color composition, plane composition, and three-dimensional structure. They compared the experiment results of the two teams and drew a conclusion that the trained team has fewer errors than those of the untrained one for the given optical phenomena. Overfitting on illusion may change the information processing method of human's eyes and brain and change the experiment results on optical illusion. Thus overfitting should be avoided in experiments of optical illusion.

II. BLIND ILLUSION

The complexity of visual perception has led to different types and degrees of deviation in people's cognition, which is optical illusion. There are many types of optical illusion, which are known as Edgar Rubin & Harrower, Lateral Inhibition, Muller's illusion, Illusion of Depth, Afterimage, Fill up illusion, Perspective illusion, Camouflage illusion,Illusion of Contour, Apparent Motion Perception[18-20].

In 2013 we found a new phenomenon: the falling speed of snowflakes which is felt by people indoors through partially blind window are faster than the one without any blinds, which is be defined as 'Blind Illusion' (BI) by us. People has little research on the novel optical illusion, and doesn't know its exact reasons. Consequently we decided to explore the phenomenon. We simulated this phenomenon on a computer, seen as Fig. 1. In this figure, a light spot represents a grain of snow, and a grey rectangle represents a piece of blinds. In previous research, Miyajima et al. (2014) discussed the apparent movements and the pursuit eye movements in BI, Tsuno et al. (2015) verified the effect of luminance difference in BI [21-22]. These research results show us some relevant factors which can affect BI, and then we will explore other factors.

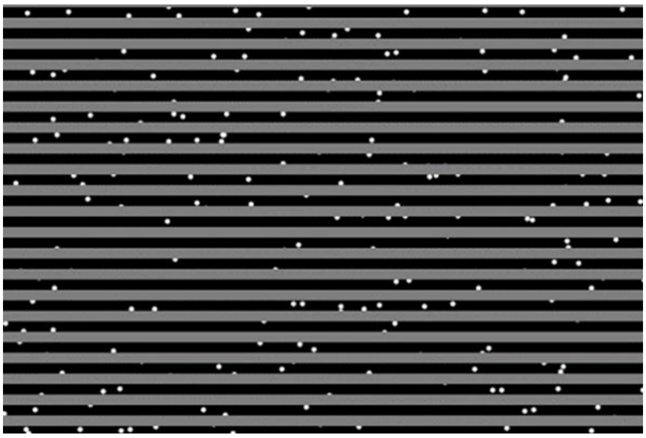

Figure 1. Blind illusion model

2.1. Relationship with speed

Following the previous simulations, some grey horizontal strips simulate the blinds and some white light spots simulate snowflakes, and experiments are carried out on a black background. From the experiments we can know that the average falling speed that the observers felt from a blind window seems about 0.3-1.0deg/s which is faster than the actual one 2.0deg/s.Thus we deduce that 'speed' is an important factor affecting BI. In this paper we'll discuss the various falling speeds of snowflakes in experiments, and explore the relationship between falling speed and illusion quantity.

2.2. Relationship with width of a blind strip

In addition to falling speed, the interval width of two blind strips is another important factor that affect BI. As a result, we take the factor into account, and change the width of blind strips in the experiments to explore the relationship between interval of blind strips and illusion quantity.

2.3. Purpose

The accurate theoretical concept of optical illusion has not been defined so far, because many researchers in various fields gave various definitions. At present, the main theoretical concepts are: Ecological Germ, Constructivism, Lateral Inhibition Neural Network, Eye Movement, Three-component Theory. The purpose of our research is to figure out the reasons that cause our brain to feel BI, the factors that affect BI and how these factors affect BI. Hence in this paper we do a lot of experiments on the two factors: the falling speed of snowfalls and the interval width of blind strips, respectively. For the former, we will verify the relationship between falling speed and illusion quantity. For the latter, we will adjust the width in order to test the boundary points of illusion. Following the previous experiments, we will adjust the speed of the white spot and the interval width of blind strips in the study.

III. EXPERIMENT I

The purpose of this experiment is to investigate how the falling speed of snowfalls affects BI. A white spot mimicking a grain of snowfall moves from the top of the black screen to the bottom and experimental participants observe the falling speed sheltering by blind strips and by no blind strips. We will record the various results at the various falling speeds and analyze the illusion quantity.

3.1. Equipment and environment

The experimental equipment is shown in Fig.2. A liquid crystal display (LCD) is selected as the prompt device in this experiment, and its parameters are shown in Table 1. The experiment will be carried out in a darkroom which prevents interference from outside light. A participant sits at an experimental table which has a distance of 600 mm far from the LCD computer screen and his head is fixed with a chin support. The answer button is put on the experimental table near the observer’s hand. Five adults with good eyesight take part in this experiment.

Table 1. Parameters of LCD.

Type	LCD-AD172SEB
Size	17 inch
Maximum range	338mm×270 mm
Resolution	1280pixel×1024 pixel
Maximum refresh frequency	75 Hz

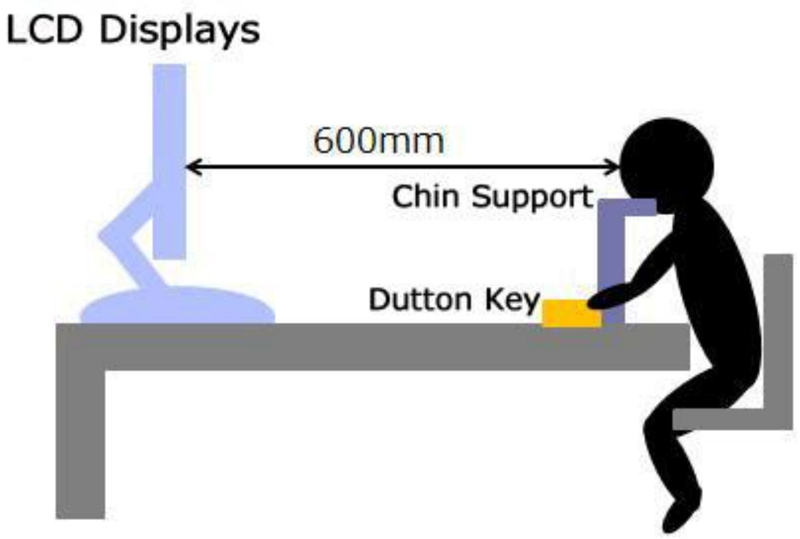

Figure 2. Experimental Equipment

3.2. Stimuli

Stimuli is shown as Fig. 3. The black (RGB = 0, 0, 0) background picture is divided vertically and equally into two sides. A red (RGB = 255, 0, 0) spot, whose visual angle is 0.1deg, is set in the center of the screen as the central fixation point in order to suppress eye movements. In the center of the left and right pictures there are white spots with 0.1deg visual angle, respectively. The two white spots will move from the top of the screen toward the bottom along vertical lines. The left picture without any sheltering is defined as a standard stimuli zone, while the right one sheltering by blind strips is defined as a comparison stimuli zone. In the right there is a grey (RGB = 128, 128, 128) rectangle on the top of the picture and there is the same one on the bottom. They are blind strips and there is an interval with 0.4deg width between them. The moving speed of the white spot in standard stimuli zone has 5 values, which are from 2.0deg/s to 4.0deg/s, and each has a 0.5deg/s increment. In comparison stimuli zone, the initial falling speed of the white spot is set according to the results of the preliminary tests.

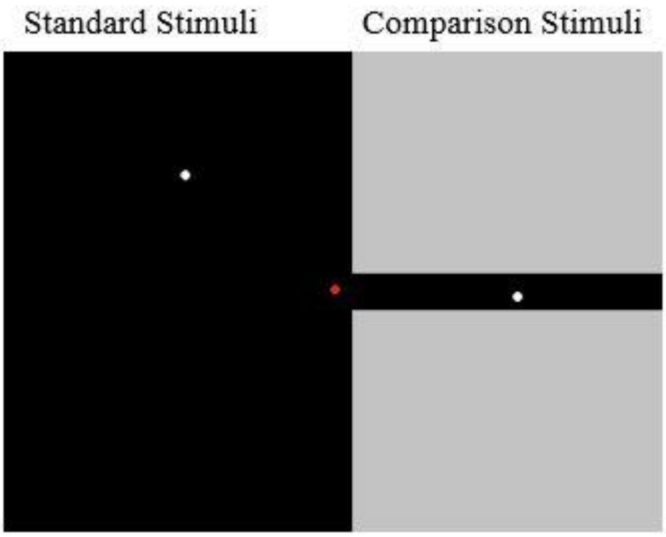

Figure 3. Stimuli

3.3. Methods and Procedure

In the experiment a participant will firstly sit for one minute in the darkness, then stare at a black screen for one second, next stare at the red fixation point for one second again, and finally he can watch a picture as Fig. 3. The participant will press the corresponding button according to the results he observes. If he feels that the spot in the comparison stimuli zone drops faster than the one in the standard stimuli zone, he will press the ‘quick’ key; otherwise he will press the ‘slow’ key. If he thinks the two speeds are equal, he will press the ‘equal’ key. These are tests with 3 options. The experimental procedure is shown in Fig. 4.

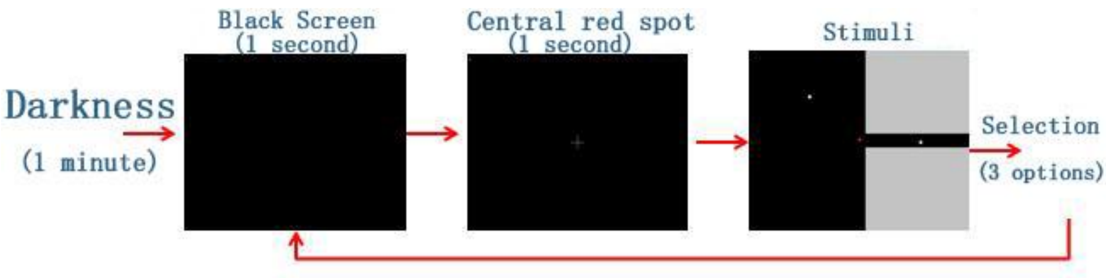

Figure 4.Experimental Procedure

We choose the method of limits as the test method of this experiment. The method has two phases: increasing and decreasing [23]. The spot in standard stimuli remains a constant falling speed which is randomly chosen from Table 2. Table 2 describes 5 speed values of standard stimuli and their corresponding initial speed values in increasing and decreasing phases of comparison stimuli which is set according to the preliminary tests. In increasing phase of comparison stimuli, the white spot will start at a slower initial speed which corresponds to the one in standard stimuli, then speed up at the rate of 0.1deg/s. In decreasing phase, the white spot start at the same speed as the corresponding one of standard stimuli, then slow down at the rate of 0.1deg/s.

Tests begin with the increasing phase. A white spot in the left of the picture falls down with a speed selected from the row of standard stimuli in Table 2, and the test system records the speed. At the same time, another white spot in the right also falls down with a speed corresponding to the standard stimuli speed. In the left there aren't any blind strips, while in the right there are two pieces of blind strips which block the falling process of the white spot. It is only visible when the white spot in the right falls to the interval of the two pieces of blind strips. At this moment the participant judges which speed is faster, the left or the right, and presses the answer button. Once the participant presses the button, the test system records the instant speed of the white spot in the right and judges whether he is right or not according the recording data. If he is right for the first time, a counter initialized to 0 increases 1; otherwise the counter is cleared to 0 and the next test remains in the increasing phase but the initial speed needs to be randomly chosen. If the counter gets to 3, the next test turns to decreasing phase, and the test procedure in the decreasing phase is similar to the one in the increasing phase, that is to say, when the counter gets to 3 in decreasing phase, the next test will turn to increasing phase again. The process from the beginning of each phase to continuous 3 correct answers is called one set of tests. We prepare 10 sets of tests for each speed value of increasing and decreasing phases in comparison stimuli. That is to say, each participant must do 300 judgements at least.

Table 2. Initial speed of the white spot.

Speed in standard stimuli	2	2.5	3	3.5	4
Speed in comparison stimuli (increasing phase)	0.2	0.4	0.6	0.8	1.0
Speed in comparison stimuli (decreasing phase)	2	2.5	3	3.5	4

3.4. Results and Analysis

We collects all the experimental data and analyze them according to the method of limits. We first introduce 3 concepts which are for each set of tests.

- Upper Limen (UL):

1) In increasing phase, it is denotes as UL_I and is an average of two speed valuesin comparison stimuli. One is the instant falling speed of the white spot at the time when the participant presses the 'quick' key and the answer is right for the first time; the other is the one at the time when the participant pressesthe 'equal' key which is right for the last time. UL_I is denoted as:

$UL_I = (S_{quick,first} + S_{equal,last})/2$ (1)

2) In decreasing phase, it denotes asUL_D and is an average of two speed values which are the instant falling speeds of the white spot at different time in comparison stimuli, too. One is recorded at the time when the participant presses the 'equal' key which is right for the first time, the other is when the participant presses the 'quick' key and the answer is right for the last time. UL_D is denoted as:

$UL_D = (S_{equal,first} + S_{quick,last})/2$ (2)

- Lower Limen (LL):

Similarly, the value of LL has two cases: in increasing phase and in decreasing phase.
It is denoted as LL_I and LL_D, respectively. They are calculated as follows:

$LL_I = (S_{equal,first} + S_{slow,last})/2$ (3)

$LL_D = (S_{slowl,first} + S_{equal,last})/2$ (4)

where$S_{equal,first}$ indicates the instant falling speed of the white spot in comparison stimuli when the participant presses the 'equal' key which is right for the first time. $S_{slow,last}$ indicates the instant falling speed when the participant presses the 'slow' key which is right for the last time. Similarly, the meanings of $S_{slowl,first}$ and $S_{equal,last}$ can be understood easily.

- Point of Subjective Equality (PSE):

PSE is the average of UL and LL, and also has two cases: in increasing phase and in decreasing one, denoted as PSEI and PSED, respectively.

$PSE_I = (UL_I + LL_I)/2$ (5)

$PSE_D = (UL_D + LL_D)/2$(6)

Then we describe what blind illusion quantity (BIQ) is. In short, it is difference between PSE and the speed of the white spot in standard stimuli, denoted as S_{std}, to which the comparison stimuli of PSE corresponds. In this paper, there are 5 different standard speed in Table 2, thus for each participant there are 5 different BIQ, defined specifically as follows:

$BIQ(i) = |PSE(i) - S_{std}(i)|$, i=1,2,3,4,5 (7)

$PSE(i) = (\overline{PSE_I} + \overline{PSE_D})/2$ (8)

$$\overline{PSE_I} = \frac{1}{n}\sum_{n=1}^{10} PSE_I(n) \qquad (9)$$

$$\overline{PSE_D} = \frac{1}{n}\sum_{n=1}^{10} PSE_D(n) \qquad (10)$$

where $\overline{PSE_I}$ and $\overline{PSE_D}$ indicate the average of PSE in increasing and decreasing phases, respectively. Combined equation5 and equation6, they're also defined as follows:

$$\overline{PSE_I} = \frac{1}{2n}\sum_{n=1}^{10}(UL_I(n) + LL_I(n)) \qquad (11)$$

$$\overline{PSE_D} = \frac{1}{2n}\sum_{n=1}^{10}(UL_D(n) + LL_D(n)) \qquad (12)$$

Accordingly, we calculate all BIQ values of 5 participants at 5 different standard speeds, listed in Table 3. From Table 3, we can know the faster the standard speed is, the larger the BIQ values of all participants are, although the specific data of each one is different. We further calculate the average BIQ values of each ones at each standard speed and we find the average BIQ is 0.928 when the standard speed is 2.0deg/s, the average one is 2.154 when the standard speed is 4.0deg/s. With the increase of the standard speed, the value of BIQ is increases. Fig. 5 shows us the ratio of the falling standard speed to BIQ.

Table 3. BIQ of 5 Participants at Different Speeds (deg/s).

Participants / Speed(deg/s)	A	B	C	D	E	AVG
2	0.76	0.76	1.05	0.96	1.11	0.928
2.5	0.79	1.03	1.36	1.27	1.45	1.180
3	1.36	1.22	1.67	1.56	1.92	1.546
3.5	1.75	1.57	1.94	1.78	2.19	1.846
4	1.98	1.95	2.18	2.16	2.50	2.154

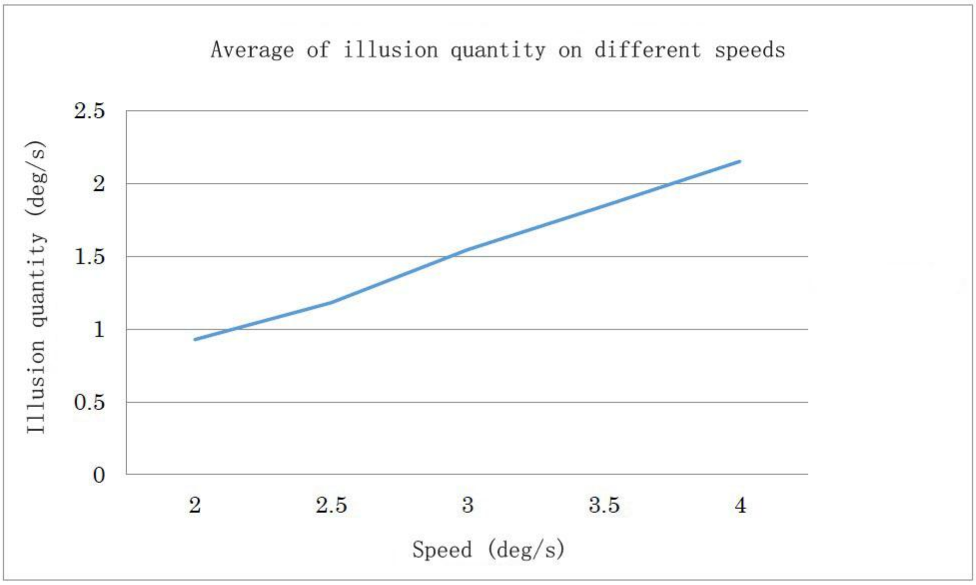

Figure 5. Relationship between Standard Speed and Average BIQ

We can get the following conclusions from the speed experimental data on BI, removing individual differences:

(1) Two grains of snowflakes fall down in the standard and comparison stimuli zone simultaneously. When the grain of snowflake appears in the visible area of comparison stimuli, although it has the same instant speed as the one in standard stimuli, people generally think that the speed in comparison stimuli is faster than the one in standard stimuli. And the faster the initial standard speed is, the greater the probability that people produce this illusion is.

(2) The quantity of BI is different because of different genders. In general, men are more likely to have delusions of speed than women.

(3) Moreover, the BIQ value in increasing phase is significantly larger than that in decreasing phase although the increasing and decreasing experiments are alternating. We speculate that it is the method of limits makes the participants have a prediction, a habit of judgement, which is the drawbacks of the method of limits [24].

IV. EXPERIMENT II

In experiment I we can see that the falling speed of snowflakes affects people's judgement of BI. Except for this factor, we have noticed that the interval width of the blind strips may have an effect on BI. Therefore, we start to verify the above deduction.

4.1. Equipment and environment

The equipment and environment in this experiment are similar to those in Experiment I, shown as Fig. 2. Unlike Experiment I, the answer device on the experimental table to will change from 3 keys to 2 keys. Specifically, in experiment I the participants can choose one of the "quick", "slow" and "equal" answers, while in experiment II they can only choose between the two answers: "quick" and "not quick". Eight adults with good eyesight take part in this experiment.

4.2. Stimuli and methods

The stimuli in Experiment II is also roughly the same as that in Experiment I, shown as Fig. 3. The left of the picture is standard stimuli zone while the right is comparison stimuli zone. Two white spots and the red fixation point are all the same.

Firstly, the interval width of two blind strips in comparison stimuli is the most important factor which this experiment verifies. Thus we set 18 different values to the interval width, from 0.1deg to 6.9deg, and the difference between each two values is 0.4deg. Secondly, we must keep the stability of the falling speed in order not to disturb the effect of the main factor. Therefore, in this experiment, the two spots in standard and comparison stimuli falls down at the same speed 2.0deg/s at the same time, and the speed remains constant during the falling process.

The experiment method is constant method. The experimental procedure is also similar to Experiment I, described as below: A participant sits at a viewing distance of 600 mm from the LCD computer screen in a darkroom. He first sit quietly for one minute, then watch the black screen for one second, and next star at the fixation point for one second, and in the last he can watch a stimuli picture. There is no shelter in standard stimuli zone while there are two blind strips in comparison stimuli zone. The interval width of the blind strips is chosen from the above 18 values randomly. When the white spot appears in the visible area, the participant starts to judge which speed is faster in the left or in the right. Of course all the participants don't know that the speeds in both sides is the same. The participant have only two answers to choose: one is that the speed in comparison stimuli is quicker than the one in standard stimuli, the other is that the former is not quicker than the latter. The screen turns black for one second after a participant finishes one selection, and then begin to show the next stimulus. Each of the 18 values repeats 30 times, and thus each participant will experience 540 tests.

4.3. Results and discussion

We collect all the experimental data from 8 participants and analyze them, firstly taking the interval width in comparison stimuli as the object. There are 18 values of interval width in this experiment. For each value, each participant has to be tested 30 times, and 8 participants takes part in this experiment in total, i.e., there are 240 tests for each width value. The system records all the judgements of "quick" and "not quick" that the participants make, then calculates a percentage of the number of "quick" to the total 240 for each width value. We draw a smooth curve to connect the actual points calculated and form an approximate curves based on the logistic regression model, shown in Fig. 6. In this figure, the horizontal axis represents the 18 values of interval width of blind strips, and the vertical axis represents the above-mentioned percentage. In this experiment BIQ is expressed in error percentage.

From this figure, we note that the narrower the interval between the blind strips is, the greater the probability that people produce BI is. Because the interval width becomes narrower and narrower, and the time the white spot spends on crossing the interval becomes shorter and shorter, the observers tends to feel that the white spot moves faster and faster. We speculate that our brain can supplement the missing trajectory of the white spot that he cannot observe according to the visible moving trajectory that he has observed to form a complete moving.

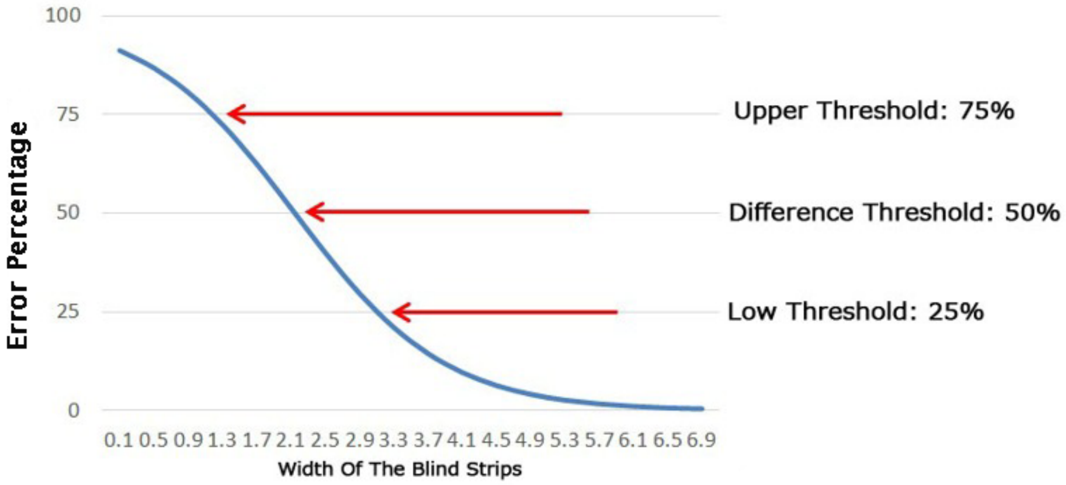

Figure 6. Logistic Regression Approximate Curve

We define 3 metrics on the basis of Fig. 6. Upper threshold (UT) is the value of the horizontal axis, i.e., the width value of the two blind strips, when the value of the vertical axis is 75%; Low threshold (LT) is the value of the horizontal axis when the value of the vertical axis is 25%; Difference threshold is the value of the horizontal axis when the value of the vertical axis is 50%. According to the data, the values of UT, LT and DT are 0.908, 2.354 and 2.136, respectively. In Fig. 6, we can be sure: BIQ will increase when the interval width is less than DT, and especially it will sharply increase when the interval width is less than UT; BIQ will decrease when the interval width is more than DT, and especially it will sharply decrease when the interval width is more than LT.

Secondly we analyze the data of each participant. Each participant takes 30 tests for each interval width, i.e., 540 tests in total. Fig. 7 describes the error percentage of Tester 1 for each interval width in detail. In the figure, the horizontal axis indicates 18 values of interval width, and the vertical axis indicates a percentage of the number of "quick" which is the answer of Tester 1 to the total 30 for each width value. According to the three values 75%, 50% and 25%, we can get the UT, LT and DT values which are 1.17, 3.13 and 2.14, respectively. Those three values are close to the average values in Fig. 6, and they are normal.

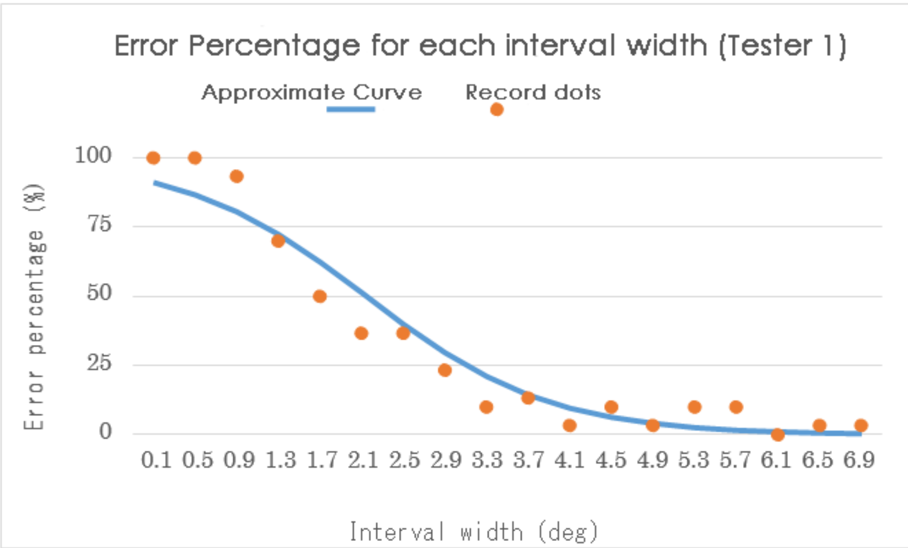

Figure 7. The Error Percentage of Tester 1 for Each Interval Width

Sequentially we further obtain all the threshold values of all the participants, shown in Table 4. We noticed that the results of the fourth testers are different from those of the others. Therefore, we analyze the error percentage of Tester 4 (T4), shown in Fig. 8, for each interval width. The description of Fig. 8 is the same as that of Fig. 7.

Table 4. Three Threshold Values of the 8 Participants

	T1	T2	T3	T4	T5	T6	T7	T8
Upper Threshold	1.17	N	1.01	2.17	1.56	N	0.32	1.03
Difference Threshold	2.14	1.30	1.66	5.30	1.99	1.31	1.63	1.76
Low Threshold	3.13	2.72	2.31	O	2.41	2.86	2.92	2.48

The UT value of T4 is 2.17deg that is much bigger than those of the others, which means his BIQ value is more than 75% when the interval width is less than 2.17deg. The DT value of T4 is 5.30deg that is much bigger than those of the others. The BIQ curve of T4 decreased linearly with the increase of interval width. We extend it and infer that the LT value of T4 is around 8.5deg, which exceed the maximum interval width of 6.9deg. The Letter O in Table 4 also indicates that its value is out of test range. The curve of T4 is completely different with the approximate curve of Fig. 6, and its values are abnormal. In future experiments we must widen the interval of blind strips so as to avoid the testing result like T4. But the more interval values will take much more test times and bring much more burden on participants. Thus we need to find a balance between test result and test burden.

The letter N in Table 4 represents we did not obtain the values. For example, UT value of Tester 2 (T2). And we analyze the error percentage of T2, shown in Fig. 9, for each interval width. The description of Fig. 9 is also the same as that of Fig. 7. The LT value of T2 is 2.72deg that is less than those of the others, which means his BIQ isn't less than 25% until the interval width reaches 2.72deg. But his DT value is 1.30deg which is much less than the average DT 2.136deg. That is to say, the BIQ of T2 has decreased to 50% before the interval width increases to 2.136deg. T2 has a more sensitive visual perception. We cannot obtain the UT value of T2 because the max value of the simulated curve of T2 is less than 75% from Fig. 9.

Combined the falling speed of snowflakes in Experiment I, we found that the faster falling speed increases the illusion quantity, and the narrower interval of the blind strips also increases the illusion quantity. We need to further explore the relationship between the former two factors.

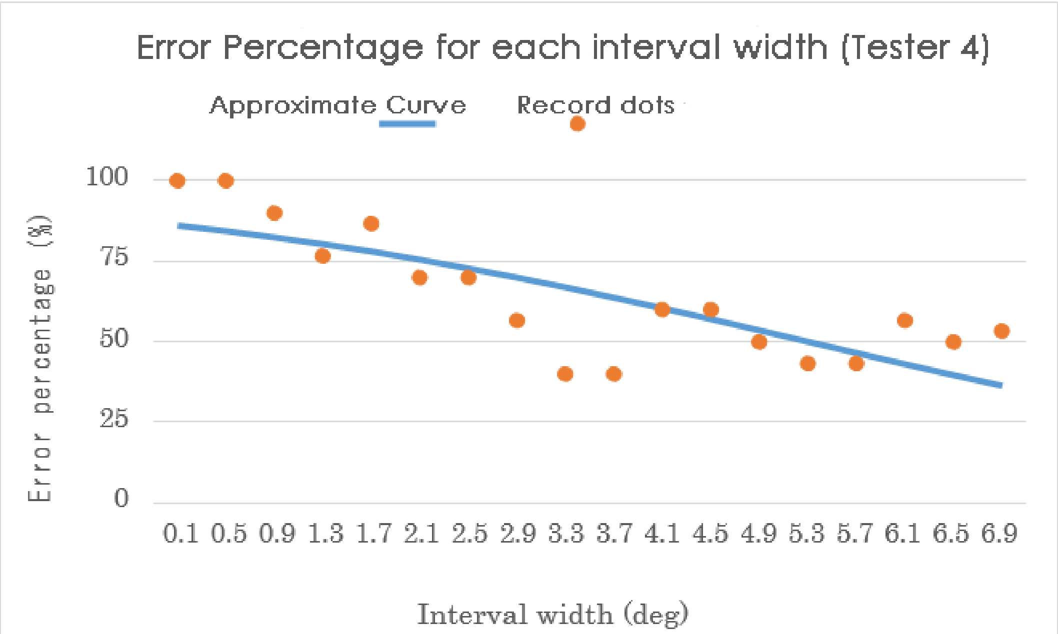

Figure 8. The Error Percentage of Tester 4 for Each Interval Width

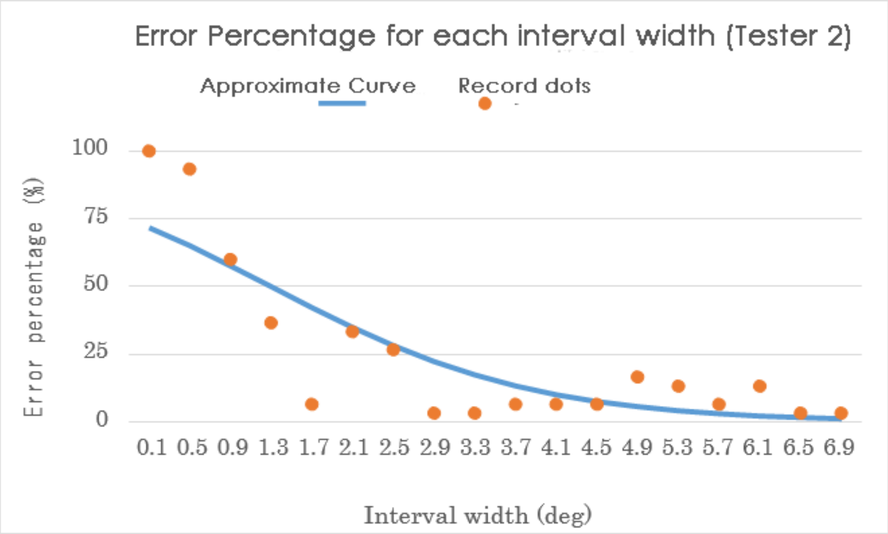

Figure 9. The Error Percentage of Tester 2 for Each Interval Width

V. CONCLUSION

In this paper the two experiments on BI are both based on the previous research. They mainly focus on two factors: the falling speed of snowflakes and the interval width of blind strips, which confuse people's visual perception and make our brain feel BI. Therefore, we carry on the detailed quantitative tests of the two factors separately, and then analyzed the true data recorded according to the experiments, and finally draw the conclusions.

From the experimental data we infer: (1) the faster the snowflakes falls, the greater the probability of BI that people feels is; (2) the narrower the interval width of blind strips, the greater the probability of BI is. Of course we need to ignore the differences between individuals taking part in the experiments. In this paper we investigate the above two factors working on BI independently, rather than working together. We will study the overlap effect of them in the future.

We also find the principle of BI tends to eye movement theory, which thinks our eyes always make regular scanning along the contours or lines of graphs when we observe graphs, and when we scan some special part of graphs, we change the direction of eye movement because of the effect of the contours, so as to the error of sampling and various illusion. In the future, we will continue to verify this theory through a number of central visual and peripheral visual experiments.

We use the method of limits in Experiment I on the study of falling speed, but find this method tends to affect the testers' next judgement. In order to prevent the tendency, we plan to use the constant method in the initial stage of the comparison stimuli. However, it will greatly increase the workload of all the experimenter. How to choose an experimental method is one of our future priorities. In addition, we also notice that the time spent by the testers in answering the questions is different. It is also necessary to consider the rule of reaction time and the burden of the experimenters.

Finally we notice that in the nature snowflakes drop from the air not along a vertical line and each grain of snowflake is not the same size, which are worth discussing. In this experiment we note the difference between male and female on BI, which maybe because of the difference of spatial perception of the brain between them [25]. Thus the study on the difference between male and female is also the important issue of our future study.

REFERENCES

[1]. Murakami, I. (2008). Visual Illusions as Clues to Brain Mechanisms. The journal of the Institute of Electronics, Information and Communication Engineers,91(9), 809-815.

[2]. Oppel, J. J. (1855). Uber geometrisch-optischeTauschungen, Jahresbericht des physikalischenVereinszu Frankfurt am Main, pp.34-47.

[3]. Zhou, H., & Fu, X. (2005). Cognitive Science—the Scientific Frontier of New Millennium [J]. Advances in Psychological Science, 13(04), 388-397.

[4]. Luo, Z., Li, Y., &Gao, X. et al. (2003). Research of the illusion multimedia software [J]. Journal of J ilinMilitaryMedi2cal College Fourth Military Medical University, 25(4), 244-246.

[5]. Xiang, M., Zhou H., & Nathans J. (1996). Molecular biology of retinal ganglion cells [J]. Proceedings of the National Academy of Sciences of the USA, 93(2), 596-601.

[6]. Peng, D. (1992). Modern theories of perception [J]. Cogni2tive Science, 26-29.

[7]. Tang, B., &Xiong, P. (1999). A Quantitative Study on Perspective Illusion and Misapplied Constancy Theory [J], Chinese Journal of Nature, 21.
[8]. Zhang, T., Sun, G., & Ma, J. (1986). AN EXPERIMENTAL STUDY OF STRUCTURAL COMPONENTS OF ILLUSIONAL FIGURES [J]. ActaPsychologicaSinica, 18(02), 64-74.
[9]. Tang, B. (1999). A Study on "Inverse Misapplied Constancy Effect" in the Visual Illusion [J]. Chinese Journal of Nature, 21.
[10]. Turner, R.S. (1993). Vision Studies in Germany: Helmholtz versus Hering [J]. Osiris, 8, 80-103.
[11]. Nakayama, K., Shimojo, S., & Silverman, G. H. (1989). Stereoscopic depth: its relation to image segmentation, grouping, and the recognition of occluded objects. Perception, 18(1), 55-68.
[12]. Petry, S., &Meyerm, G.E. (1987). The perception of illusory contours. State: Springer Science and Business Media.
[13]. Stevens, G. P. (1962). Concerning the Impressiveness of the Parthenon, American Journal of Archaeology, 66(3), 337-338.
[14]. Coren, S., &Porac, C. (1987). Individual differences in visual-geometric illusions: Predictions from measures of spatial cognitive abilities. Perception and Psychophysics, 41(3), 211-219.
[15]. Coren, S., &Girgus, J. S. (1978). Seeing is deceiving: The psychology of visual illusions. Lawrence Earlbaum, Hillsdale, New Jersey, States: JSTOR.
[16]. Ozaka, R. (1985). "Why is the moon of the horizon big?", Kodansha. [Published in Japanese]
[17]. Ichikawa, M., Ejima, H., Kinoshita, T., & Long, A. (2000). "Visual design training and visual process change", Vision Society of Japan, 12, 97-100. [Published in Japanese]
[18]. Eagleman, D. M. (2001). Visual illusion and neurobiology [J]. Nature Reviews Neuroscience, 2(12), 920-926.
[19]. Kong, B. (2002). Comparison between human vision and computer vision [J]. Chinese Journal of Nature, 24(1), 51-55.
[20]. Nieder, A. (2002). Seeing more than meets the eye: processing of illusory contours in animals [J]. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology, 188(4), 249-260.
[21]. Miyajima, R., Tang, Z., & Yamashita, K. (2014). "The influence of the pseudo-motion and the par-chute eye movement in blind illusion", Toyama, Toyama University. Thesis. [Published in Japanese]
[22]. Tsuno, J., Tang, Z., & Yamashita, K. (2015). "Basic research of a speed optical illusion by a blind (The influence luminance difference exerts) ", Toyama, Toyama University. Thesis. [Published in Japanese]
[23]. Nakano, N. (1995). "Psychological physical measurement method", Vision Society of Japan, pp. 17-27. [Published in Japanese]
[24]. Nakano, N. (1995). "Psychological physical measurement method", Vision Society of Japan, pp. 46-49. [Published in Japanese]
[25]. Voyer, D., Voyer, S. &Bryden, M. P. (1995). Magnitude of sex differences in spatial abilities: a meta-analysis and consideration of critical variables, American Psychological Association, 117(2), 250.