A SURVEY OF EFFECT OF DECLINING AND ROTATING ON HERMANN GRID

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ABSTRACT

The Hermann grid illusion is an optical illusion. The illusion is characterised by "ghostlike" grey smudges perceived at the intersections of a white (or light-colored) grid on a black background. In advertisement, some designers used to make vision illusions to confuse consumers. The responsibility of advertisement designers should be telling the truth to consumers, but not treating consumers by vision illusions. So in the research we wanted to know how to stop the vision illusions, then designers won't cheat consumers by vision illusions.

In the research we used "Method of Constant Stimuli". Stimuli were presented numerous times in random order and the subject reports whether he/she could detect them. In stage 1, 16 subjects were sophomores of Department of Creative Design of National Yunlin University of Science and Technology. And in stage 2, we had 20 subjects from Multimedia Design Department of Fortune Institute of Technology, all of them were sophomores. In the research we declined and rotated the squares in Herrmann Grid to get the absolute thresholds. In stage 1, the absolute threshold of the experiment 1 was 12°, and the absolute threshold of the experiment 2 was 8°. In stage 2, the absolute threshold of the experiment 1 was 14°, and the absolute threshold of the experiment 2 was 6°. In the research we had three control factors, 'direction of vertical lines' and 'direction of horizontal lines', and 'decreasing the area of squares'. When declined the squares, the control factors are 'direction of vertical lines' and 'decreasing the area of squares'. When rotated the squares, the control factors are 'direction of vertical lines' and 'direction of horizontal lines'. The effect of 'decreasing the area of squares' was much more then the effect of 'direction of horizontal lines'.

Keywords: *Hermann Grid, Vision Illusion, Absolute Threshold*

1. INTRODUCTION-WHAT IS HERMANN GRID

This figure is called the Hermann grid after L. Herman (1870). The dark smudges can be explained by reference to receptive fields and lateral inhibition. Dark smudges (patches, blobs) appear in the street crossings, except the ones which you are directly looking at. The Hermann grid illusion consists of smudges perceived at the intersections of a white grid presented on a black background. In 1960 the effect was first explained by a theory advanced by Baumgartner suggesting the illusory effect is due to differences in the discharge characteristics of retinal ganglion cells when their receptive fields fall along the intersections versus when they fall along non-intersecting regions of the grid.

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Hudák M F, Geier J, 2007	"Modelling with flying colours: The application of the RadGrad model to chromatic Hermann grids"	Perception **36** ECVP Abstract Supplement
Geier J, Bernáth L, Hudák M, Séra L. (2008).	"Straightness as the main factor of the Hermann grid illusion".	Perception **37** (5): 651 – 665.
Michael W Levine, J Jason McAnany	The effects of curvature on the grid illusions	Perception, 2008, volume 37, pages 171 - 184

Table 1: The research history of Hermann Grid

Hermann's Grid is an example of lateral inhibition — a mechanism of our visual system. Light sensitive cells are arranged in rows on the retina and it is possible to stimulate just one cell, called Cell X, to send a signal to the brain. If, however, Cell X's neighbors are also stimulated, Cell X's signal won't be as strong. Stimulating the neighbors of any particular cell actually inhibits the strength of that cell's response. This means that the strength of any signal sent from the retina is dependent on the signals nearby. The places where the white lines in Hermann's Grid intersect have white surroundings in four different directions so they appear darker than they actually are.

Kevin Berbaum, Chan Sup Chung(Berbaum K, Chung C S, 1981, p85 – 89) mentioned the Hermann grid has been explained in terms of concentric receptive fields and also used to determine the size of centers and surrounds in perceptive fields in humans. A new figure, which is simply the outlines of the squares of the Hermann grid, shows that receptive fields having a range of excitatory and inhibitory sizes may be responsible for the Hermann illusion.

The range of application of Hermann grid and visual illusion is from Graphic Design to Media Design and Advertisement Design. After World War Two there is a common view internationally that war is destroy for human. Then some designs become tools of colonization. Some designs encourage unnecessary consumption by confuse consumers. But designers should tell the truth to consumers, not should cheat consumers for consumption. It is the responsibility for designers to educate consumers correct perceptions of consumption.

2. THE RESEARCH ON DESTROYING HERMANN GRID

János Geier, Lászlo Bernáth, Mariann Hudák, Lászlo Séra(Geier J, Bernáth L, Hudák M, Séra L, 2008, p 651 – 665) noted the generally accepted explanation of the Hermann grid illusion is Baumgartner's hypothesis that the illusory effect is generated by the response of retinal ganglion cells with concentric ON – OFF or OFF – ON receptive fields. To challenge this explanation, they have introduced some simple distortions to the grid lines which make the illusion disappear totally, while all preconditions of Baumgartner's hypothesis remain unchanged. To analyse the behaviour of the new versions of the grid, they carried out psychophysical experiments, in which they measured the distortion tolerance: the level of distortion at which the illusion disappears at a given type of distortion for a given subject. Statistical analysis has shown that the distortion tolerance is independent of grid-line width within a wide range, and of the type of distortion, except when one side of each line remains straight. They conclude that the main cause of the Hermann grid illusion is the straightness of the edges of the grid lines, and we propose a theory which explains why the illusory spots occur in the original Hermann grid and why they disappear in curved grids.

Michael W Levine, J Jason McAnany(Levine M W, McAnany J J, 2008, 171 – 184) commented Grid illusions, including the Hermann grid and scintillating grid (in which light disks are superimposed upon the grid intersections), are diminished by curving the alleys that limn the repeating pattern. Curvature might either disrupt the processes that induce the illusion, or simply make the illusory effects harder to see. To determine which mechanism might be invoked, they examined the effects of curving the alleys upon the vanishing-disk illusion, a phenomenon in which a single disk in a grid intersection is rendered less detectable. This illusion is of reduced visibility, rather than generating an illusory apparition as in the Hermann grid or scintillating grid. Thus, inhibition of illusory influence would enhance disk visibility, while a general reduction of visibility would render disks even harder to detect. They find that thresholds for both scintillation and the disk itself increase in a graded manner with increased curvature. Measuring the effect of curvature upon the vanishing disk with traditional forced-choice staircase methods demonstrates that the effect of curvature is upon detection, not subjective criterion. Furthermore, disks that are easy to detect within a rectilinear grid are more difficult to detect when the alleys are curved. Thus, curvature of the alleys induces a general tendency to inhibit the visibility of features, and is not specifically a repression of illusory effects.

In 'Stopping the Hermann grid illusion by simple sine distortion', Geier J, Sera L, Bernath(2004) proposed the Baumgartner model predicts that the illusion is independent from the relative directions of the right-angled intersections. Some authors (Wolfe, 1984 Perception 13:33–40; for a review see Ninio and Stevens, 2000 Perception 29:1209–1217) show that the magnitude –not the existence– of the illusion depends on certain geometrical properties. They made some simple distortions to the Hermann Grid that makes the illusion disappear totally while the Hermann-grid character remains. The most effective of these was to replace the straight lines with sine curves leaving the intersections right-angled. The illusion is found to disappear at a surprisingly small sine amplitude (amplitude/period <1/10). They supported these results with psychophysical measurements (n=29). Simple geometrical consideration shows that the distortions produced here do not change the weighted sum of the receptive field.

In "The Hermann grid illusion revisited", Peter H Schiller, Christina E Carvey proposed seven viewpoints to challenge *retinal ganglion cell theory* and *Baumgartner model*. Indeed, there are los of problems in *retinal ganglion cell theory* and *Baumgartner model*. In our research, we try to get the answers with designers' viewpoints.

3. ABSOLUTE THRESHOLD

Absolute threshold is the minimal amount of energy necessary to stimulate the sensory receptors. A term often used in neuroscience and experimental research. An absolute threshold is the smallest detectable level of a stimulus. For example, how much does the power of a massage chair should provide to make customers feel comfortable.

Upper absolute threshold is the maximal amount of stimulus to the sensory receptors. When the amount of stimulus is more than upper absolute threshold, then the sensory receptors have no sense.

Definition: Absolute threshold is the lowest intensity at which a stimulus can be detected.

4. PSYCHOLOGICAL INVESTIGATIONS OF PERCEPTION

Fechner's 3 methods for determining absolute threshold

4.1. Method of Constant Stimuli:

1. A number of stimulus intensities (5-10 typically) are selected beforehand by the researcher.

2 The stimuli are presented numerous times in random order and the subject reports whether he/she can detect them.

3 A graph is plotted showing percent of times detected as a function of stimulus intensity.

4 The point at which the stimulus was detected 50% of the time is deemed the absolute threshold.

4.2. Method of Limits:

1 The researcher starts with a stimulus clearly above threshold, and asks the subject if he/she can detect it.

2 The researcher keeps adjusting the intensity of the stimulus down in fixed increments until the subject reports that it can no longer be detected.

3 This process is repeated several times, sometimes ascending and sometimes descending.

4 The average of the "cross-over" points is deemed the absolute threshold.

4.3. Method of Adjustment

The intensity of the stimulus is adjusted by the observer until it can just be detected.

5. EXPERIMENT DESIGN

5.1. Stage 1 and Stage 2

Both in Stage 1 and Stage 2, we used 'method of Constant Stimuli' to get the value of absolute threshold, and we had two experiments. In the first experiment we right declined the squares in Hermann Grid from 0° to 20°, every following drawing increased 2° than the former one. In the second experiment we rotated the squares in Hermann Grid from 0° to 20°, every following drawing increased 2° than the former one. We used Microsoft Office Excel 2003 to make all the drawings for experiments. All of the experiments we had the squares with height 1.01cm and width 1.01cm. Every square was in a grid with a height 53 pixels(6 points, almost 1.32cm) and a weight 53 pixels(39.75 points, almost 1.32cm). In stage 1, our subjects were sophomores of Department of Creative Design of National Yunlin University of Science and Technology. In the first experiment we had 15 subjects, and in the second experiment we had 16 subjects. And all of the subjects do the experiment in the same time. In stage 2, we had 20 subjects, all of them were sophomores of Multimedia Design Department of Fortune Institute of Technology, 7 subjects were males and 13 subjects were females. And the subjects did the experiment one by one.

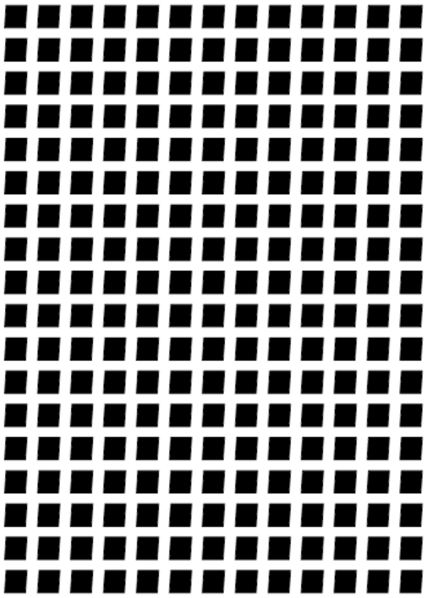

Diagram 1. Decline the square 2°

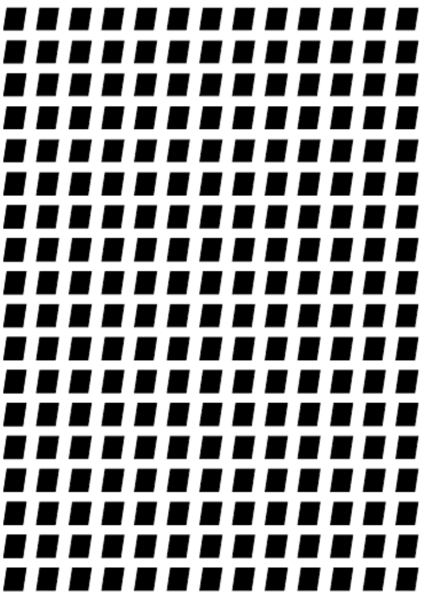

Diagram 2. Decline the square 10°

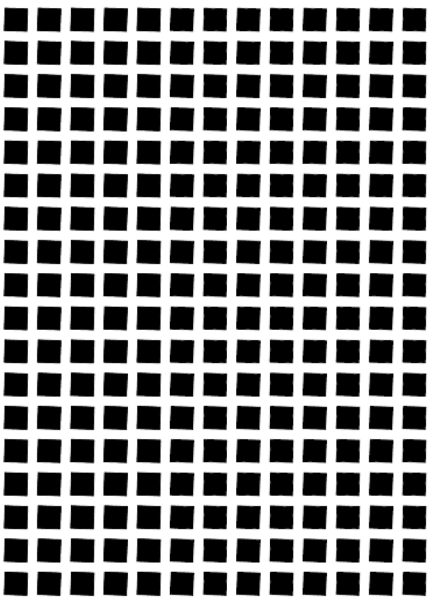

Diagram 3. Rotate the square 2°

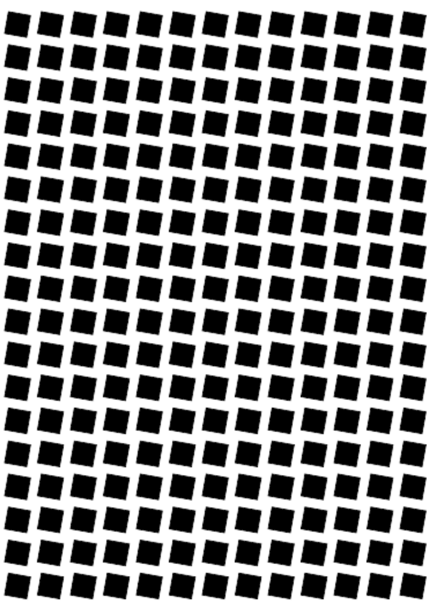

Diagram 4. Rotate the square 10°

6. RESULT

6.1. Stage 1

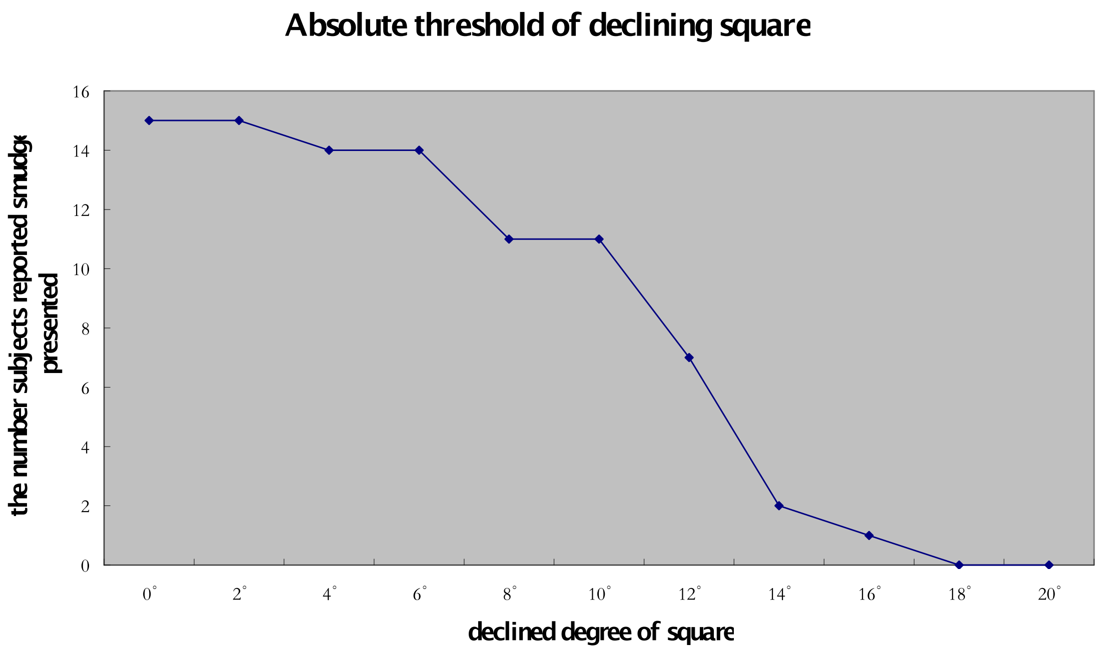

Diagram 5. Result of Experiment 1

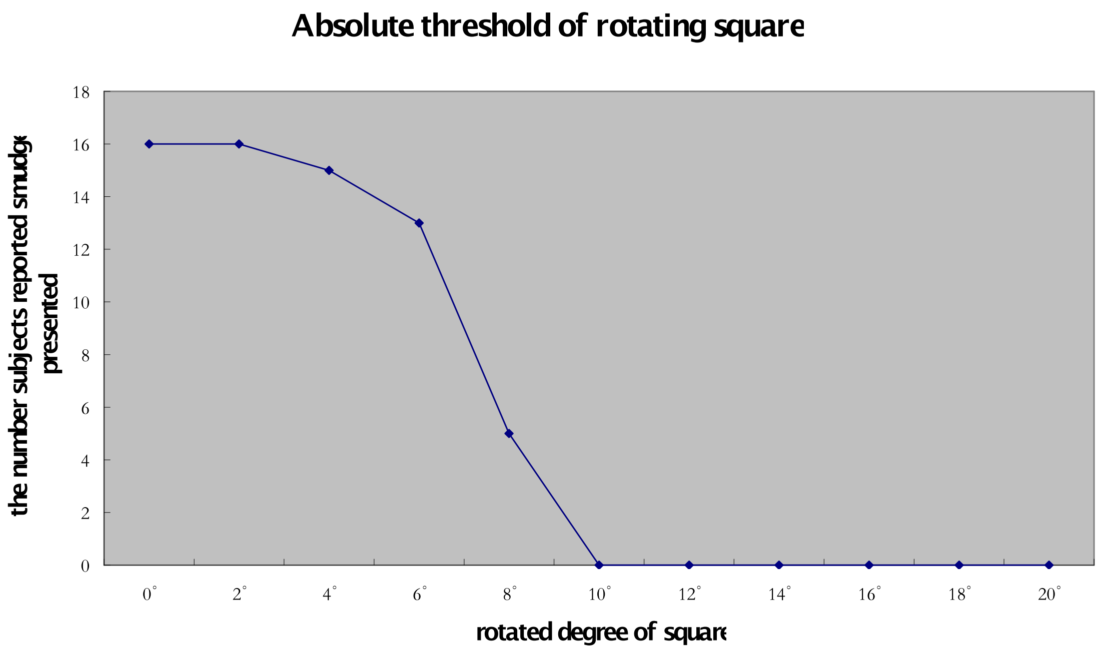

Diagram 6. Result of Experiment 2

In **Diagram 5,** when we right declined the squares, the absolute threshold is 12°. In **Diagram 6,** when we rotated the squares, the absolute threshold is 8°. In the stage, we assumed that the absolute threshold of both experiments is 6°.

6.2. Stage 2

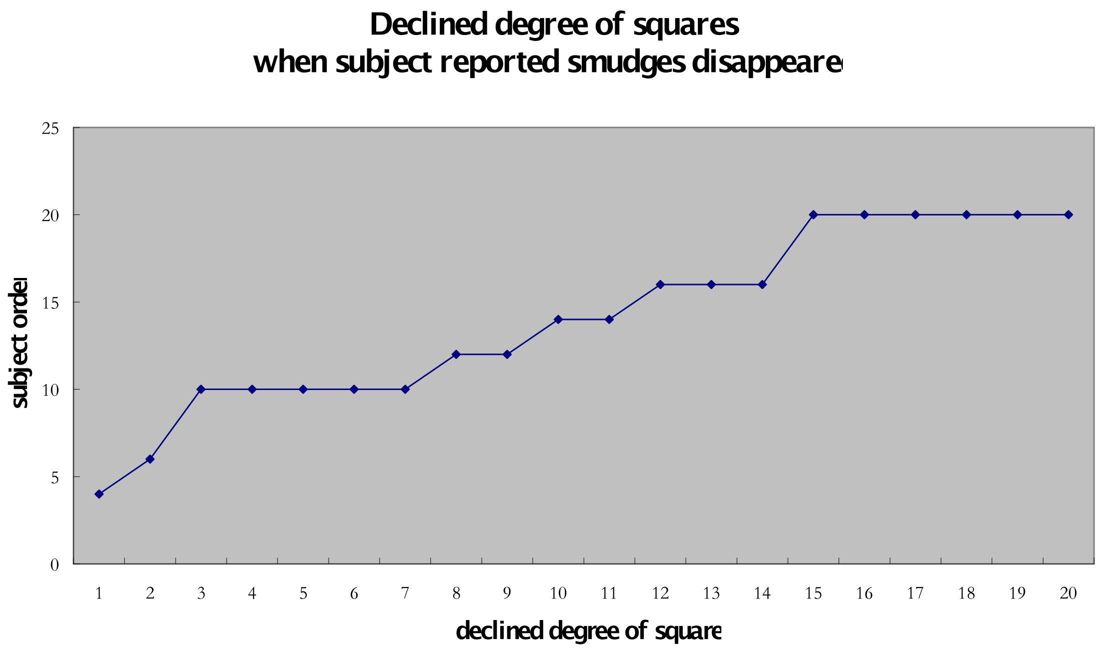

Diagram 7. Result of Experiment 1

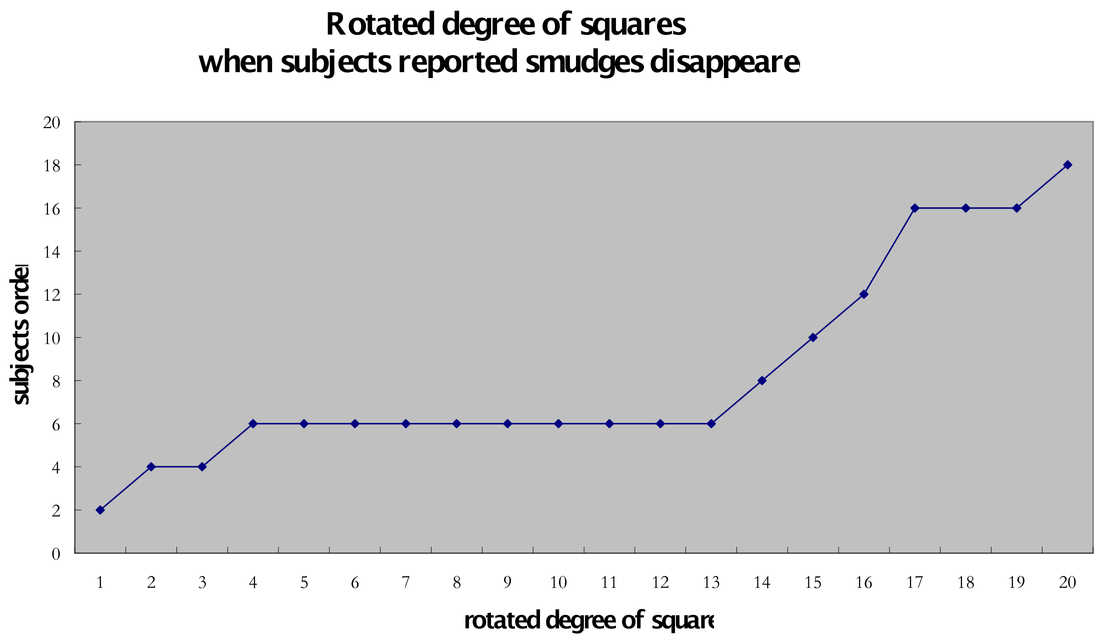

Diagram 8. Result of Experiment 2

In **Diagram** 7, when we declined the squares, the absolute threshold is 14°. In **Diagram** 8, when we rotated the squares, the absolute threshold is 6°. In stage 2, we still assumed that the absolute threshold of both experiments is 6°. In stage 1, the absolute threshold of the experiment 1 is 12°, and the absolute threshold of experiment 2 is 8°. In stage 2, the absolute threshold of experiment 1 is 14°, and the absolute threshold of the experiment 2 is 6°. The result of the two stages is little different. But in both stages, the smudges disappear quickly when we rotated the squares.

7. DISCUSS

The Hermann grid illusion consists of intersecting vertical and horizontal white bars superimposed on a black background, thereby forming an array of evenly spaced black squares. At the intersection of the bars, ghostly gray smudges are perceived comprising the illusion.

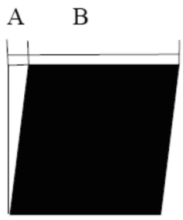

Diagram 9

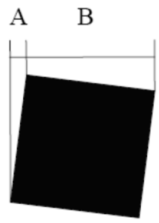

Diagram 10

In Diagram 9, when the length of A is 1/10 of B, the square declines near 6°. In Diagram 10, when the length of A is 1/10 0f B, the square rotates near 6°. Our assumption in the research was that when the squares in Hermann Grid were inclined or rotated to 6° (It means the part distorted is almost 1/10).

In stage 1, the absolute threshold of the experiment 1 was 12°, and the absolute threshold of experiment 2 was 8°. In stage 2, the absolute threshold of experiment 1 was 14°, and the absolute threshold of the experiment 2 was 6°. The result of the two stages was little different. But in both stages, the smudges disappeared quickly when we rotated the squares.

In the research we had three control factors, 'direction of vertical lines' and 'direction of horizontal lines', and 'decreasing the area of squares'. When declined the squares, the control factors are 'direction of vertical lines' and 'decreasing the area of squares'. When rotated the squares, the control factors are 'direction of vertical lines' and 'direction of horizontal lines'. The effect of 'direction of horizontal lines' was much more then the effect of 'decreasing the area of squares'.

Style of squares	**Control factors**
Right decline the squares	'direction of vertical lines' and 'decreasing the area of squares'
Rotate the squares	'direction of vertical lines' and 'direction of horizontal lines'

Table 6. Control factors of Experiments

In the experiments we fixed the width and the height of the square on 1.01cm. When we right declined the squares, the area of squares will decrease; when we rotated the squares, the area of squares will keep constant. So we assumed the smudges will disappear earlier when we declined the square. But the result was opposite to the assumption. Then we find another factor to stop Hermann Grid, **the declined angle of horizontal line**. In this research we get more factors to stop Hermann Grid, **the declined angle of vertical line** and **proportion of squares**. In the future researches and experiments, we hope we can get the weight of factors effect on stopping Hermann grid.

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