Distortion tolerance of the Hermann grid

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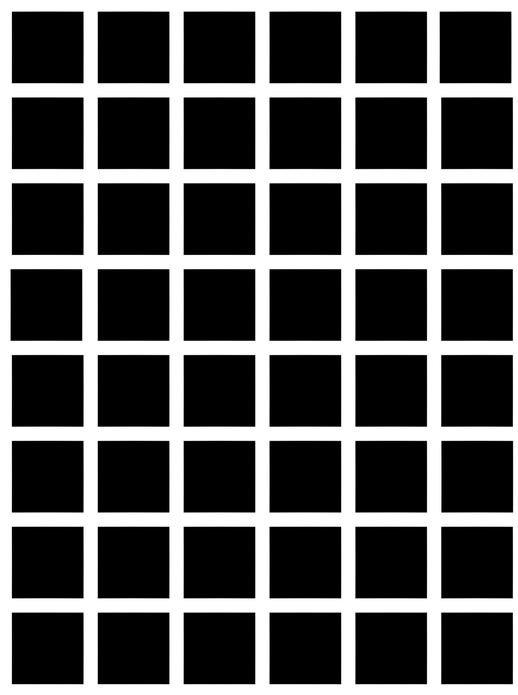
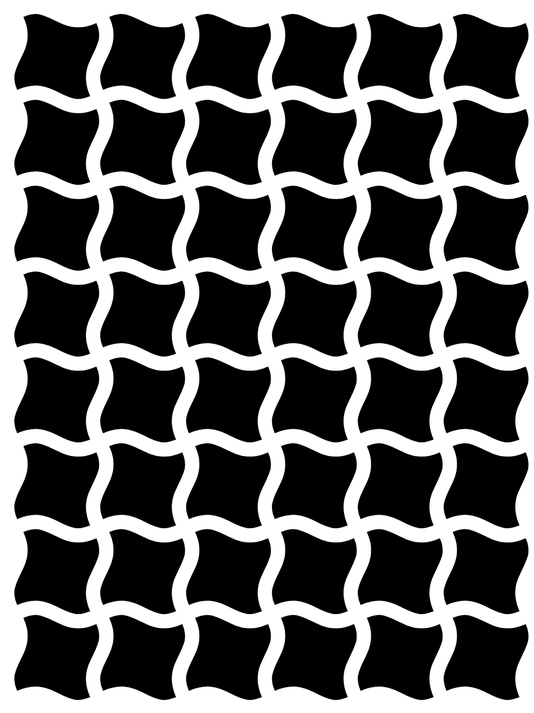
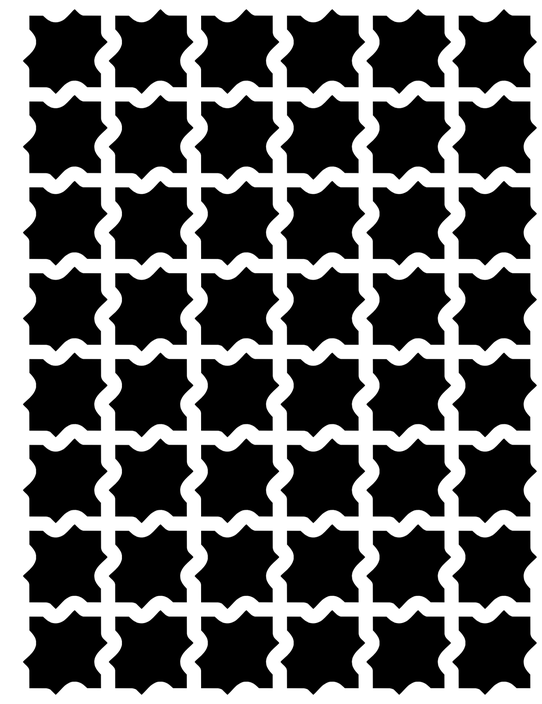


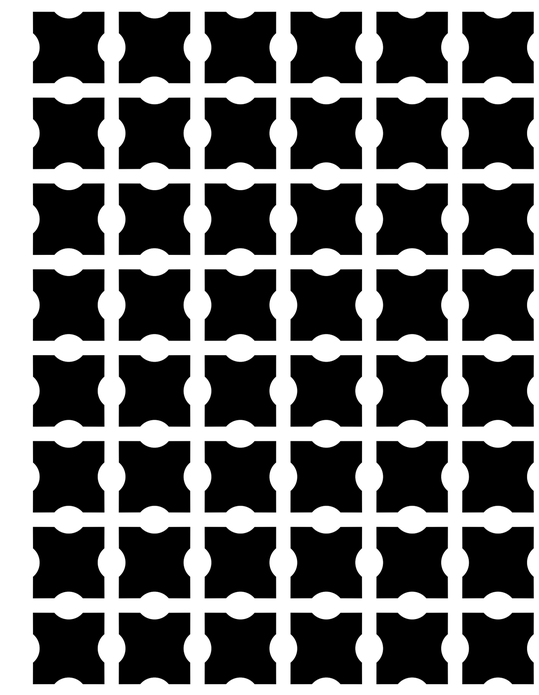
Hermann grid



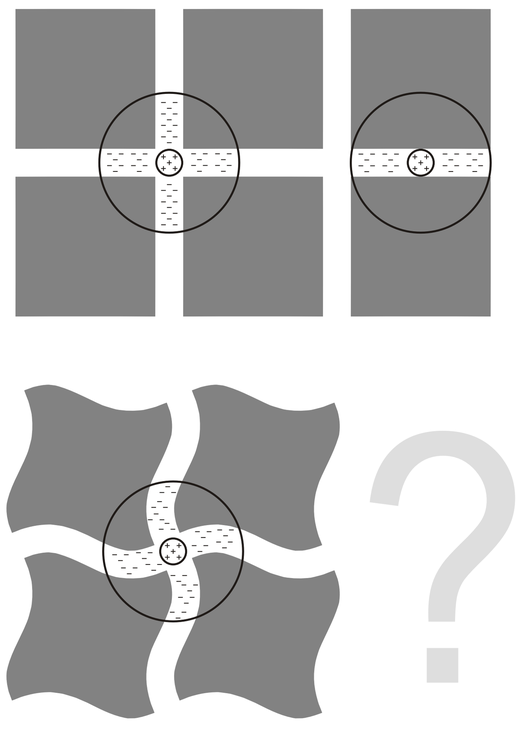
Sinusoid grid (1)



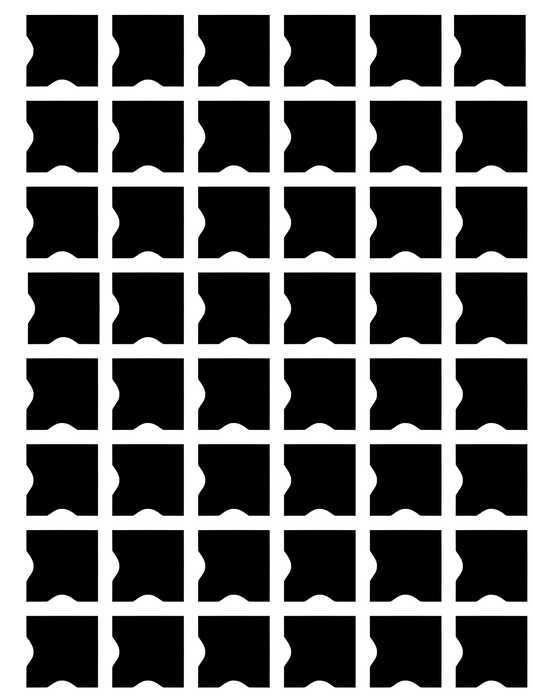
Wavy grid (2)



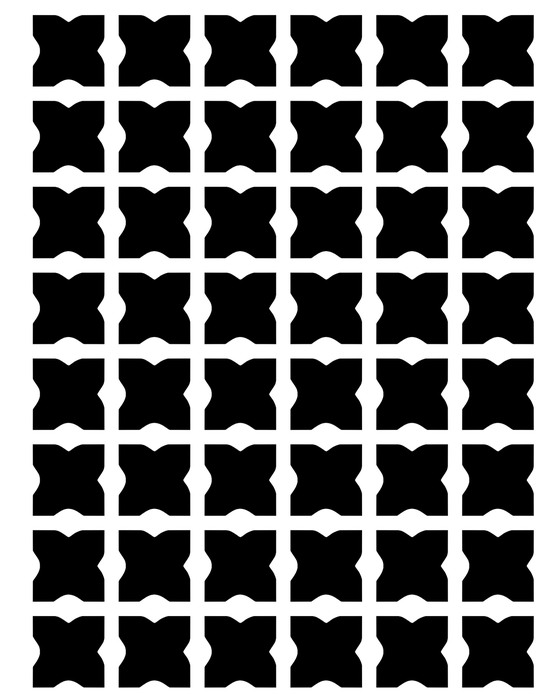
Knotted grid (3)



Humped grid (4)



Half sided humped grid (5)



Asymmetrical humped grid (6)

The problem

- You can see that the Hermann grid illusion disappears by applying certain distortions to the lines. What is the cause?
- The 'official model' of the classical Hermann grid illusion is the Baumgartner (or lateral inhibition) model. The basis of that model is the unbalanced weighting sum of the different areas in concertic on-off or off-on receptive fields.
- Evidently, the Baumgartner model is not a sufficient explanation of that new phenomenon.

Experiment

Definition: At a given distortion type and at a given subject, starting from straight lines and increasing the distortion level step by step, the *distortion tolerance* means: that distortion level when the illusion disappears.

ANOVA model:
- Dependent variable was the distortion tolerance.
- Independent variables were the distortion type and the line width. (See above the 6 distortion types.)

Method

- Stimuli were shown in random order on a computer monitor:
  d= 15 inches , 1024×768 pixels, viewing distance 60 cm,
  gazing with free eye movements.
- Distorted Hermann grids included 7×5 white lines on a black background, with 3 different line widths (11, 17, and 23 pixels), with constant line spacing (102 pixels).
- There were twenty-two subjects (n=22).

Measuring the distortion tolerance

- The subject saw 3x6=18 pictures (3 different line widths and 6 distortion types).
- The experimental program generated the successive exposition of pictures and made random order of line widths and of distortion types. The base of distortion was a classical Hermann grid.
- The instruction for subject was to increase the distortion till the illusion disappears.

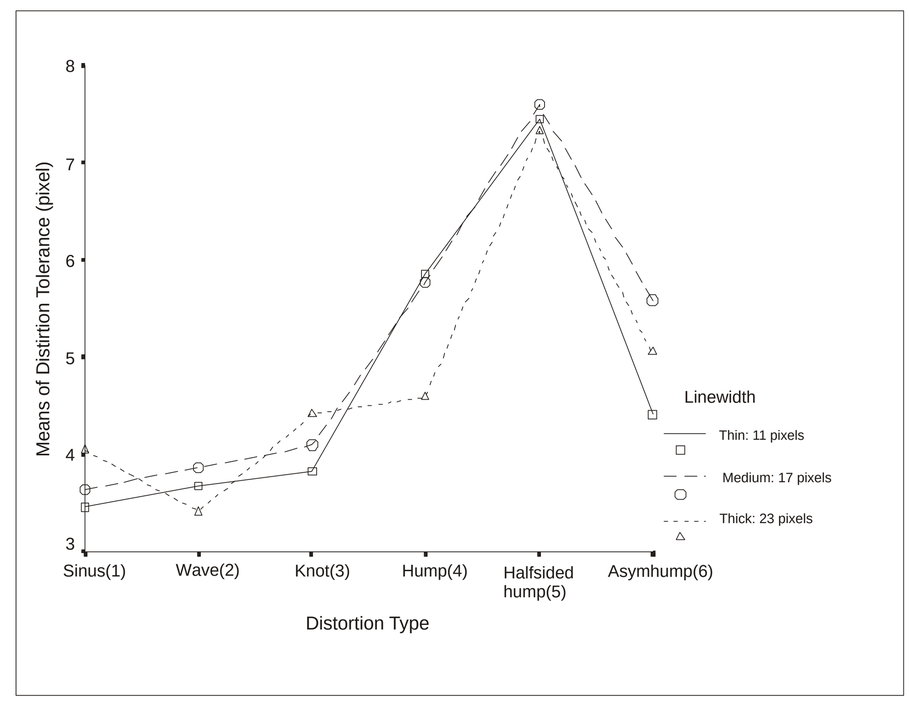
Results

Two-way ANOVA showed that
- the main effect of distortion type is highly significant ($F_{5,105}$ =15.708, p<0.01);
- the main effect of line width is not significant ($F_{2,4}$ = 0.649, p>0.05);
- interaction is not significant ($F_{10,210}$ = 1.163, p>0.05).

Pairwise comparison showed that
- differences between the *half sided humped line* (5) and every other line type were significant;
- differences between all other pairs were not significant.

Conclusions

- The main cause of the Hermann grid illusion is the *straightness of the black-white edges*;
- line width measure plays no significant role;
- line width homogenity plays no significant role;
- the Baumgartner model is not adequate to explain the Hermann grid illusion;
- to modelling the distortion phenomenon need to be found on the straightness of the balck-white line sides - instead of the weighting sum of the on-off areas.



Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
LINEWID	Pillai's Trace	,111	1,254[a]	2,000	20,000	,307
	Wilks' Lambda	,889	1,254[a]	2,000	20,000	,307
	Hotelling's Trace	,125	1,254[a]	2,000	20,000	,307
	Roy's Largest Root	,125	1,254[a]	2,000	20,000	,307
DISTORTI	Pillai's Trace	,717	8,614[a]	5,000	17,000	,000
	Wilks' Lambda	,283	8,614[a]	5,000	17,000	,000
	Hotelling's Trace	2,534	8,614[a]	5,000	17,000	,000
	Roy's Largest Root	2,534	8,614[a]	5,000	17,000	,000
LINEWID * DISTORTI	Pillai's Trace	,476	1,088[a]	10,000	12,000	,438
	Wilks' Lambda	,524	1,088[a]	10,000	12,000	,438
	Hotelling's Trace	,907	1,088[a]	10,000	12,000	,438
	Roy's Largest Root	,907	1,088[a]	10,000	12,000	,438

a. Exact statistic

b.
Design: Intercept
Within Subjects Design: LINEWID+DISTORTI+LINEWID*DISTORTI

Within-Subjects Factors

Measure: MEASURE_1

LINEWID	DISTORTI	Dependent Variable
1	1	SINUS11
	2	WAVE11
	3	KNOT11
	4	HUMP11
	5	HSKNOT11
	6	ASHUMP11
2	1	SINUS17
	2	WAVE17
	3	KNOT17
	4	HUMP17
	5	HSKNOT17
	6	ASHUMP17
3	1	SINUS23
	2	WAVE23
	3	KNOT23
	4	HUMP23
	5	HSKNOT23
	6	ASHUMP23

Descriptive Statistics

	Mean	Std. Deviation	N
SINUS11	3,45	1,371	22
WAWE11	3,68	1,937	22
KNOT11	3,82	1,868	22
HUMP11	5,86	4,754	22
HSKNOT11	7,45	6,375	22
ASHUMP11	4,41	1,919	22
SINUS17	3,64	1,590	22
WAWE17	3,86	2,031	22
KNOT17	4,09	1,411	22
HUMP17	5,77	3,624	22
HSKNOT17	7,59	3,924	22
ASHUMP17	5,59	2,856	22
SINUS23	4,05	1,618	22
WAWE23	3,41	1,436	22
KNOT23	4,41	1,501	22
HUMP23	4,59	1,790	22
HSKNOT23	7,32	4,581	22
ASHUMP23	5,05	2,681	22

Pairwise Comparisons

Measure: MEASURE_1

(I) DTYP	(J) DTYP	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
6	2	6,061E-02	,202	1,000	-,607	,728
	3	,594	,282	1,000	-1,328	,540
	4	-1,697	,515	,052	-3,402	8,316E-03
	5	-3,742*	,794	,002	-6,372	-1,113
	6	-1,303*	,265	,001	-2,180	-,426
2	1	6,061E-02	,202	1,000	-,728	,607
	3	-,455	,178	,274	-1,042	,133
	4	-1,758*	,482	,023	-3,353	-,162
	5	-3,803*	,789	,001	-6,415	-1,191
	6	-1,364*	,279	,001	-2,287	-,440
3	1	,594	,282	1,000	-,540	1,328
	2	,455	,178	,274	-,133	1,042
	4	-1,303	,504	,260	-2,972	,366
	5	-3,348*	,785	,005	-5,947	-,750
	6	-,909	,358	,288	-2,096	,277
4	1	1,697	,515	,052	-8,316E-03	3,402
	2	1,758	,482	,023	,162	3,353
	3	1,303	,504	,260	-,366	2,972
	5	-2,045*	,433	,002	-3,478	-,613
	6	,394	,437	1,000	-1,054	1,841
5	1	3,742*	,794	,002	1,113	6,372
	2	3,803*	,789	,001	1,191	6,415
	3	3,348*	,785	,005	,750	5,947
	4	2,045*	,433	,002	,613	3,478
	6	2,439*	,736	,050	2,146E-03	4,877
6	1	1,303*	,265	,001	,426	2,180
	2	1,364*	,279	,001	,440	2,287
	3	,909	,358	,288	-,277	2,096
	4	-,394	,437	1,000	-1,841	1,054
	5	-2,439*	,736	,050	-4,877	-2,146E-03

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

References

Baumgartner, G. 1960 „Indirekte Grössenbestimmung der receptiven Felder der retina beim Menschen mittels der Hermannscher Gitteraushung." *Pflügs Archiv für die gesamte Psychologie*, **272**, 21-22.

Geier, J., Sera, L., and Bernath, L. 2004 „Stopping the Hermann grid illusion by simple sine distortion." *Perception*, 33, ECVP 2004 supplement, 53