Predicting Perceptions: Proceedings of the 3rd International Conference on Appearance, pp. 112-114, Edinburgh, UK, ISBN 978-1-4716-6869-2, April 2012.

Illusory Modification of Lightness in "Anomalous" Figures

Lucia Zanuttini
Dipartimento di Scienze Umane, Università di Udine
Via Petracco 8
33123 Udine, Italy
lucia.zanuttini@uniud.it

1. ABSTRACT
Illusory modification of the enhanced lightness connected to the appearance of "anomalous" figures, with illusory contours, is investigated in Ebbinghaus like displays.

2. INTRODUCTION
Illusory contours are those perceived without any luminance or colour change between two areas. A classic example of illusory contours is the "Kanizsa triangle" (Kanizsa, 1976).

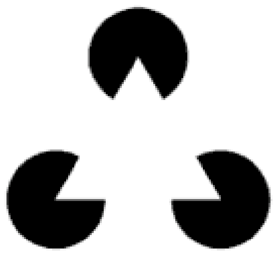

Fig. n. 1 Kanizsa triangle: the 'sides' seen extending between the discs are illusory, as the difference in lightness of the triangle and the white background.

Observers see a white triangle on the top of three black disks; the white triangle appears lighter, although it has the same luminance of the white background. Also squared or irregular "anomalous" figures can be created (Kanizsa & Gerbino, 1987). Several competing explanations have been put forward for the effect (Dumais, & Bradley, 1976; Coren, 1991; Ramachandran & Rogers-Ramachandran, 2005), which will not be discussed in this context. The lightness/brightness of a surface is a function of the luminance of the area (candles/mq); when the same intensity is spread over a larger area the luminance decreases, and "normally" also the lightness is. Phenomenal modifications of lightness have been considered mainly in situations in which surfaces are affected by contrast, when different luminance/reflectance areas are simultaneously present (Li & Gilchrist, 1999; Gilchrist & Radonjić, 2009) Lightness can also be affected by illusory modification of the magnitude of an area: a white disk, when inside a small concentric circle (a display like those originally proposed by Delboeuf), looks not only larger but also lighter than when surrounded by a larger one. Increased size and lightness appear correlated (Zanuttini, Daneyko & Zavagno, 2009). This effect is counterintuitive, as the same intensity is spread over a larger area (Zanuttini & Danejko, 2010). The same lightness effect has been observed with the Ebbinghaus figure; moreover when the central disk is grey it looks darker (Danejko, Zavagno. & Zanuttini, 2011). What will happen of the lightness of an anomalous figure, when the size of the packs is manipulated in a Delboeuf or Ebbinghaus like manner?

3. THE EXPERIMENT
The aim of the present experiment was to modify the exquisitely phenomenal lightness of an anomalous figure through an illusory modification of its size, effect that in previous experiments has proved to affect perceived lightness. It is assumed that the packs, contributing to the onset of an anomalous square, can behave as the inducing circles in an Ebbinghaus display: the smaller the disks, the larger the anomalous figure.

3.1 Method
Three anomalous figures produced by packs of increasing size were used as experimental stimuli. In order to counteract the increased contrast effect, as the packs were enlarged they were proportionally lightened; two conventional squares (one darker and one lighter than the background) were added. The displays were presented according to the *Pair Comparison Method* (Thurstone, 1927). Each square (3cm wide) came into view for 3 sec, randomly on a monitor (Apple Cinema Display, 20 inch widescreen) on both the left and right side of the screen, four times, at a viewing distance of approximately 70 cm.

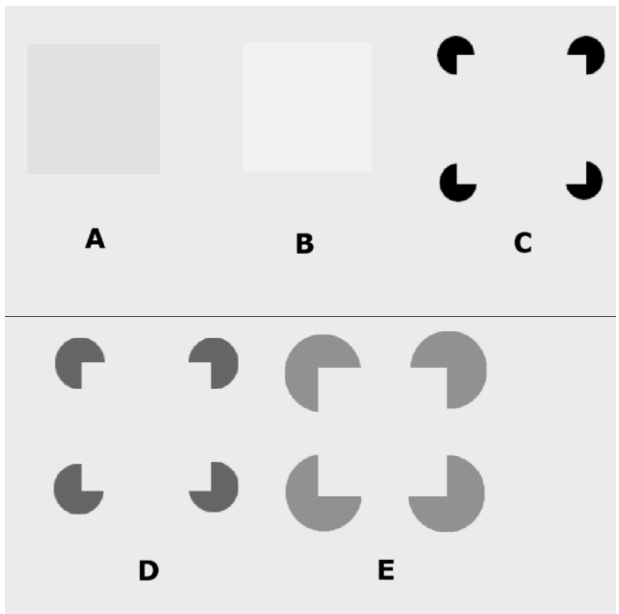

Fig. n. 2 Experimental displays (Photoshop Grayscale).

Predicting Perceptions: The 3rd International Conference on Appearance, 17-19 April, 2012, Edinburgh, UK. Conference Proceedings Publication ISBN: 978-1-4716-6869-2, Pages: 112-114

Thirty students, ages 20 to 25, took part in the experiment in a room with almost total darkness. First they were asked (twice) to evaluate the magnitude of the squares (i.e. which one looked larger in each pair). Then the same figures were presented according to the same procedure, and the observers had to say (twice) which was lighter.

3.2 Results

Scale separations have been computed both for squares magnitude and square lightness (Guilford, 1954).

Table 1. Proportions of the time each display has been judged larger.

	A	D	E	C	B
A	**.500**	**.692**	**.766**	**.792**	**.816**
D	**.308**	**.500**	**.458**	**.592**	**.742**
E	**.233**	**.542**	**.500**	**.584**	**.700**
C	**.208**	**.408**	**.484**	**.500**	**.725**
B	**.183**	**.258**	**.300**	**.275**	**.500**[5]
Σzjk [6]	-2.9408	-.2752	-.1163	.6583	2.6719
Mzjk [7]	-.5881	-.0550	-.0232	.1316	.5343
Rj [8]	.000	.5331	.5649	.7197	1.1224

The perceived size of the anomalous squares appears to be affected by the size of the inducing packs: the smaller the pack s, the larger the inside square.

Table 2. Proportions of the time each display has been judged lighter.

	A	D	E	C	B
A	**.500**	**.692**	**.766**	**.792**	**.816**
D	**.308**	**.500**	**.458**	**.592**	**.742**
E	**.233**	**.542**	**.500**	**.584**	**.700**
C	**.208**	**.408**	**.484**	**.500**	**.725**
B	**.183**	**.258**	**.300**	**.275**	**.500**[5]
Σzjk [6]	-2.9408	-.2752	-.1163	.6583	2.6719
Mzjk [7]	-.5881	-.0550	-.0232	.1316	.5343
Rj [8]	.000	.5331	.5649	.7197	1.1224

The perceived lightness varies with the magnitude of the inducers[9]: the anomalous square C with the smaller packs looks the lightest (except square B, lighter than the background) and
square D appears the darkest (except square B, darker than the background).

4. DISCUSSION

Both the perceived size of the "anomalous" squares and the phenomenal lightness, at the basis of their appearance, are affected by the size of the packs. Nevertheless the order and the distance of the stimuli on the two different continua are not the same. The perceived anomalous area increases as the size of the packs decreases. The lightness, on the other hand, is at a maximum in display C (smallest packs) and at a minimum in display D (intermediate packs). The enhanced luminance of the packs in E might have produced some interfering contrast effect. The magnitude of a figure that has only a phenomenal existence can be illusorily modified, and it's perceived lightness can be affected, without any change in the surface luminance. More experiments are needed to clarify whether the two different effects merely concur or whether they are, in some way, causally connected.

5. REFERENCES

[1] Coren, S. 1991. Retinal mechanisms in the perception of subjective contours: the contribution of lateral inhibition, *Perception,* 20, 181-191.

[2] Daneyko, O., Zavagno, D. & Zanuttini, L. 2011. The effect of size-contrast illusions on lightness, *Perception*, 4, 464-473.

[3] Dumais, T. & Bradley, D.R. 1976. The effects of illumination level and retinal size on the apparent strength of subjective contours. *Perception & Psychophysics*, 19, 339-345.

[4] Gilchrist, A.L. & Radonjić, A. 2009. Anchoring of lightness values by relative luminance and relative area, *Journal of Vision*, 9, 13 1-10 http://journalofvision. org/9/9/13/, doi: 10.1167/9.9.13.

[5] Guilford, J.P. 1954. *Psychometric Methods*. New York: Mc-Graw-Hill Book Company.

[6] Kanisza, G. 1976. Subjective contours. *Scientific American,* 234, 48–52.

[7] Kanizsa, G. & Gerbino, W. 1987. Can we see constructs? In *The Perception of Illusory Contours*. Eds. S. Petry & G. E. Meyer. New York: Springer, 246-252.

[8] Li, X. & Gilchrist, A. 1999. Relative area and relative luminance combine to anchor surface lightness values *Perception & Psychophysics,* 61, 771-785.

[9] Ramachandran, V.S. & Rogers-Ramachandran, D. 2005. The Reality of Illusory Contours. How can an imaginary square look more real than a box with actual lines? *Scientific American*, 21, 96-95.

[10] Thurstone, L.L. 1927. A Law Of Comparative Judgment. *Psychological Review*, 34, 273-286.

[11] Zanuttini, L. & Daneyko, O. 2010. Illusory lightness in the Delboeuf Figure. *Perceptual and Motor Skills*, 111, 799- 804.

[12] Zanuttini, L., Daneyko, O. & Zavagno D. 2009. Illusory Modifications of Area and Apparent Lightness. Eds. M. Elliott, S. Antonijevic, *Proceedings of the 25° Annual Meeting of the international Society for Psychophysics*, 283-288.

[1]Scale separations between pairs (matrix Z).

[1]	B	A	E	D	C z scores
B	/	.0401	1.5622	1.8250	2.1201
A	- .0401	/	1.3787	1.4985	1.7279
E	-1.5622	-1.3787	/	1.1503	.8705
D	-1.8250	-1.4985	-1.1503/	/	1.0625
C	-2.1201	-1.7279	-.8705	-1.0625	/

[2] Σ*zjk:* sums of the columns in matrix Z.

[3] M*zjk*: average of the original matrix transformed in Z scores to represent the psychological distance on the magnitude continuum (Thurstone, 1927).

[4] R*j*: scale values obtained by giving the value zero to the lowest stimulus in the list.

[5] Scale separations between pairs (matrix Z)

	A	D	E	C	B
A	/	.5015	.7257	.8134	.9002
D	-.5015	/	-.1055	.2327	.6495
E	-.7257	.1055	/	.2121	.5244
C	-.8134	-.2327	-.2121	/	.5978
B	-.9002	-.6495	-.5244	-.5978	/

[6] Σ*zjk:* sums of the columns in matrix Z.

[7] M*zjk*: average of the original matrix transformed in Z scores to represent the psychological distance on the lightness continuum.

[8] R*j*: scale values obtained by giving the value zero to the lowest stimulus in the list.

[9] The order is supported by the experimental proportion matrix, not significantly different from the theoretical one ($\chi = 3.069$, 6 df, p=.80)