Giovanni Bruno Vicario

# Optical-Geometrical Illusions: The Measurement

## 1. Introduction

Some years ago, G. H. Fisher published on *Perception* (1973), a short paper - just one and a half pages - that once and for all destroys the naïve belief that we can "measure" the effects of an optical-geometrical illusion by comparing what we see with what there is on the paper or on the monitor, when this latter is formulated in physical and geometrical terms. The title of the paper was: *But if they either are not what they seem, or seem what they are not, then how can perceptual distortions be measured?*

In this article I will elucidate and develop Fisher's argument, first in visual terms, and then in theoretical ones. I never found in the literature on psychophysics an insight of such a purport. I am not acquainted with retorts to Fisher's paper, and I will be grateful for any suggestions.

## 2. Fisher's Argument

Suppose we had to measure the illusion of length in the inverted T display, as the following figure 1 shows. As anyone knows, the two lines in the display are geometrically equal, but the vertical looks far longer than the horizontal one.

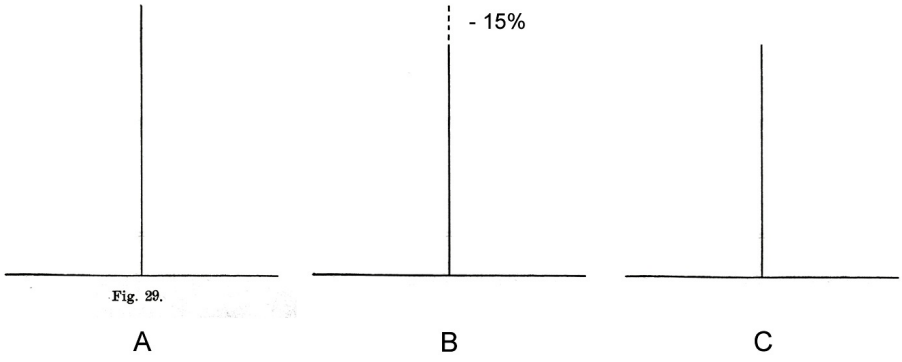


**Fig. 1:** Measuring the illusion of length in the inverted T display (see the text).

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In **A** we see the inverted T illusion in the form provided by Schumann (1900*29)[1]. In **B** is depicted the usual way to measure the illusion: shortening the vertical till the two lines are perceived as equal in length. According to Künnapas (1955, graph of fig. 2), the shortening must be around 15%. In **C** we see the inverted T with the two lines perceptually equal.

Fisher argues that in **A** the two (physical) lines *are not what they seem* (they are equal, and not unequal as they seem), and in **C** the two (perceived) lines *seem what they are not* (they seem equal, but are in fact unequal): an illusion of length is present also in **C**. His remark is that *"traditional experimental procedures necessarily imply that one example of perceptual distortion can only be evaluated in terms of another"***.** His conclusion is that *"in absence of psychological standards comparable with their physical counterparts, it is debatable whether illusory distortions can be claimed to have been measured satisfactorily".*

### 3. Comment

The *coup de foudre* that supports Fisher's argument is undoubtedly the revelation that the **C** figure is not the physical stimulus, but *another* illusion of length. The experimenter becomes therefore trapped between two unwelcome perceptual data, and the physical reality of the stimulus is lost. The first conclusion by Fisher is then impeccable: we can evaluate a perceptual distortion only by comparing it with another distortion – of the same species, of course.

At this point Fisher seems to be frightened by his own conclusion, because it undermines the theoretical ground of psychophysics: the possibility of comparing the perceptual data with the physical reality. The second conclusion is therefore that we cannot measure *satisfactorily* illusory distortions because of the absence of *psychological standards* comparable with their physical counterparts.

In my opinion, the second conclusion of Fisher is at least bizarre. In the first place, what does he mean by "satisfactorily"? It does not mean "exactly", and the satisfaction of a measure depends not on its accordance with the "reality", but on the use of it: sometimes a certain grade of tolerance is accepted, and in other cases is refuted. In the second place, what on earth is "a psychological standard comparable with its physical counterpart"? Fisher has just demonstrated that the physical counterpart is not attainable (**C** is not the physical stimulus, but another optical-geometrical illusion); why now is he dreaming of an improbable "psychological standard"?

[1] The asterisk means 'figure'. See *Gestalt Theory 30,* 176.

## 4. Protagoras' Intuition

The questions raised by Fisher are impressive, but misleading. He did not realize that a peer comparison between a matter of experience (like a percept) and a matter of thought (like a geometrical or a physical concept) is impossible, because of the heterogeneity of terms. On the contrary, the point was clearly grasped by Protagoras, as Aristotle testifies (*Metaphysica*, 997b35).

> "For neither are perceptible lines the same lines[2] the geometer speaks of (for no perceptible thing is straight or round in the way in which he defines straight or round; for a hoop touches a straight edge not at a point, but as Protagoras used to say it did, in his refutation of the geometers)."

A representation of the case is perhaps useful. Look at figure 2, where (1) the lines have the same thickness, and (2) the radius of the lower circumference is 4 times the radius of the upper one (Vicario 2008). [2]

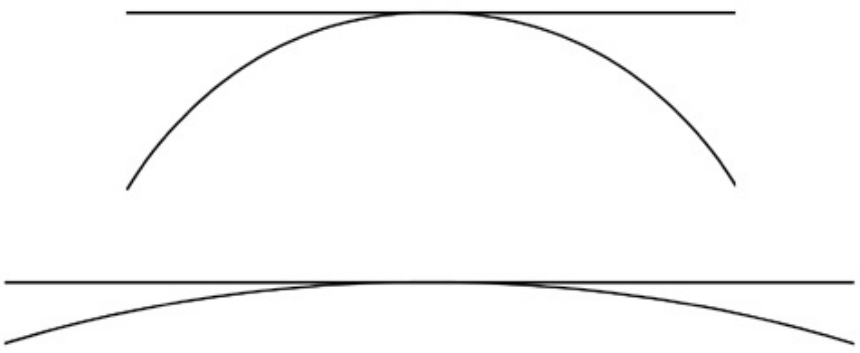

**Fig. 2:** Protagoras' illusion: a straight line has more than one point in common with a circumference. The radius of the lower circumference is 4 times the radius of the upper one (Vicario 180908a-b: Images prepared by G.B. Vicario on 18th September 2008).

As one can directly see, the straight line and the circumference appear to share more than a single point, and the number of common points increases as the radius of the circumference increases.

To sum up, straight lines, arcs of circles, triangles *etc*. of geometry are not objects of perception, but useful concepts which allow the formulation of practical problems and their solution by means of calculations. As concepts, they are

[2] I took the liberty of amending the English rendering by Ross (2007) in this point. He translates the Greek word *toiautái* with "such as", while the very meaning of that adjective is "actually the same". By the way, one can ask himself why to quote Protagoras, as Aristotle holds the same point. The reason is quite apparent: Aristotle's sentence is generic, where Protagoras' statement is punctual and verifiable. Ehrenstein (1954, 25) was the first who spoke of a "Protagoras' illusion".

objects of thought, which we encounter only when we move forward in the virtual space of geometry or physics.

## 5. Kant's Formalization

Protagoras' intuition finds its formal expression in Kant, who clarified once and for all the point, with the introduction of the concepts of *phenomenon* (the object of direct experience) and *noumenon* (the object of thought; see *De mundi sensibilis etc.*, §3; *Prolegomena etc.*, §32). The "physical counterpart" invoked by Fisher is a noumenon, which we cannot come upon in everyday experience of our environment.

Yet naïve realism, that makes physical and geometrical concepts more "real" than our perceptions, is diehard. Kant knew perfectly this common attitude, and wrote (*Prolegomena etc.*, §33):

> "There is indeed something seductive in our pure concepts of understanding [geometrical and physical concepts], which tempts us to a trascendent use, a use which trascends all possible experience."

And added this ironical comment:

> "Hence the categories seem to have a deeper meaning and import than can be exausted by their empirical use, and so the understanding inadvertently adds for itself to the house of experience a much more extensive wing, which it fills with nothing but creatures of thought, without ever observing that it has transgressed with its otherwise lawful concepts the bounds of their use." (Translation edited by P. Carus.)

This is a comment that had to be reminded the day before yesterday to introspectionists, yesterday to cognitivists and today to neuropsychologists. In terms of psychology, when Fisher complains of the "absence of physical counterparts" for optical-geometrical illusions – and generally for any else perception – he understands that we have to judge what we see by means of what we *presume* to know about the elusive "physical reality". This attitude has even a noun: it is the so-called *stimulus error* (see Vicario 1998).

## 6. Mach's Solution of Fisher's Problem

Fisher has no reasons for complaining that "one example of perceptual distortion can only be evaluated in terms of another".

In his *Mechanik in ihrer Entwicklung historisch-kritisch dargestellt* (1883/1988, II, 6), Mach demonstrates that the qualification and the measurement of a motion cannot be referred to absolute space and time, but only to another motion. Generally speaking, lengths are measured by means of other lengths, durations by other durations, changes by other changes. I cannot see why "illusions" should not be measured by means of other "illusions".

In my opinion, the source of any uneasiness is the term "illusion", because the term does not refer to percepts only, but to other mental facts as well. For example to *expectations*: if I trace two equal lines, I expect that they will appear equal also when they are differently positioned, say the one horizontally, the other vertically. For another example: if I have two lines which I see equal in length, and then I add to the one ingoing fins, and to the other outgoing fins – a little apart from the lines, as in the Müller-Lyer variant by Yanagisawa 1939 – I notice that they have changed their visible length, even if the added lines do not interfere with previously traced lines, so that I expected that the previous lines cannot change their length. If we substitute to "illusion" the term "percept", and we consider the case in point a matter of comparisons between percepts, Fisher's problem ceases to exist.

Also in this form the problem finds its solution in Mach. He says (*ibidem*): "All metaphysical obscurities vanish when we realize that science intends to discover *the mutual dependence of phenomena only*". In no way does it try to discover a *true* reality hidden behind phenomena. And adds: "No one can claim to know any else thing about it. It is therefore a useless metaphysical concept". The target of Mach's censure was the concept of absolute time, but we can say that all formal entities by which we describe the contents of direct experience are metaphysical. They are not absolute sticks for the measurement of percepts, but necessary tools which allow the comparison between percepts.

Mach's point is more than a philosophical one. As I recently reported (Vicario 2009), there is today in physics a significant trend (known as *effective theories*, originated by a paper by Fermi 1934), which is very "phenomenological". It is characterized by the sole consideration of the "effects" emerging from experimentation, *without* any reference to the "causes", that is to supposed entities physically "real".

## 7. Conclusion

Even if weakened in its final inference, Fisher's argument remains remarkable. If presented in the way I tried to do, it sweeps away the belief that better methods of measurement will at last give us the *true* nature of the stimulus that generates an optical-geometrical illusion. There is undoubtedly something "psycho-" in psychophysical measurement, but there is not something "physical" in the sense of a reality otherwise recognizable. Besides, psychophysical methods do not seem to me directed to finding an equation linking percepts to such elusive stimuli. We cannot *see* other's people perceptions, so that we must solely trust in their verbal reports (Libet 1965, 78). But verbal responses are in part due to the stimuli and in part due to subjects' expectations, guesses, motives and so on – the same occurs if we substitute verbal reports with motor responses. In this light, psychophysical methods appear as ever more astute procedures for separating the

most probable phenomenal content due to stimulation – which is the primary scope of our experiments – from the aforesaid parasitical components of verbal reports.

**Summary**

Fisher's argument (1973) on the measurement of optical-geometrical illusions is expounded. While his argument is impeccable (we can measure illusions only by means of other illusions) his conclusions have to be rejected (we cannot satisfactorily measure illusions in absence of psychological standards comparable with their physical counterparts). The reasons were already clearly explained by Protagoras (in Aristotle), Kant and Mach: it is impossible to compare objects of direct experience (percepts) with objects of thought (concepts). Protagoras' argument is illustrated by means of two figures.

**Keywords:** Psychophysical measurement, optical-geometrical illusions, visual perception.

**Zusammenfassung**

Fishers Argumente (1973) über die Messung von optisch-geometrischen Täuschungen werden dargelegt. Während seine Argumentation einwandfrei ist (wir können Täuschungen nur mittels anderer Täuschungen messen), müssen seine Schlussfolgerungen zurückgewiesen werden (wir können Täuschungen nicht befriedigend messen, solange psychologische Standards, die mit ihren physikalischen Pendants vergleichbar wären, fehlen). Die Gründe dafür wurden schon deutlich von Protagoras (in Aristoteles), Kant und Mach erläutert: es ist unmöglich, Objekte der direkten Erfahrung (Wahrnehmungsgegenstände) mit gedanklichen Objekten (Konzepten) zu vergleichen. Protagoras Behauptung wird mittels zweier Abbildungen veranschaulicht.

**Schlüsselwörter:** Psychophysische Messung, optisch-geometrische Täuschungen, visuelle Wahrnehmung.

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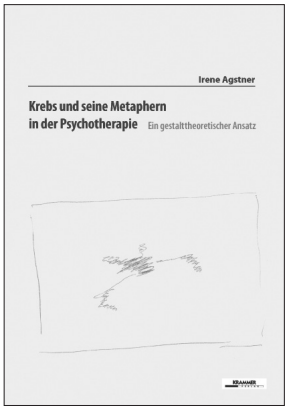


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