

The Shrinking Twin

Pierre Sabatier¹

¹ Independent researcher, Paris, France

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Abstract

In this version of the Twin paradox the travelling twin is supposed to have been lying horizontally on a couch in the direction of his movement during his whole trip: he has been a victim of length contraction. He is shorter when he is back than when he departed. Is his size real or apparent?

His size depends on the reference frame where it is measured. It is then observer-dependent. Therefore, contrary to what is assumed by Naïve realism, it is not real.

This tends to show that, when Relativity is concerned, Naïve realism, the philosophical foundation of classical physics, is not pertinent any more and a different realism is required.

Keywords: Twin paradox, Special Relativity, naïve realism, length contraction

Langevin's twin paradox is widely known: a pair of twins live side by side on Earth. Then one of them flies away in a spaceship travelling at a speed close to the speed of light. When he is back on Earth, he is younger than his twin - because his time has been slowed down by his movement relatively to his brother.

This paradox is usually considered only in a temporal perspective. Here we'll consider it in a spatial perspective.

Suppose that during his whole journey the travelling twin was lying horizontally on a couch oriented in the direction of his spaceship's movement. He has been a victim not only of time dilation, but of length contraction. When he is back on Earth, he is shorter than when he left it.

Length contraction is a delicate matter. Time dilation is something rather abstract which can be accepted without asking too many questions. Length contraction is much more concrete, much more challenging to common sense.

Physicists prefer to avoid this problem. Einstein himself was puzzled by length contraction and could not decide whether it is real or apparent (Giovanelli, 2023). This is because Einstein, as most physicists, was thinking in the terms of Naïve Realism (Miller 2024, Beck 2019).

Naïve realism, the philosophical foundation of physics, of which Scientific Realism is a variant, is based on two assumptions:

- 1) There is an objective, ontological, observer-independent reality encompassing everything that exists. It is universal and one. In accordance with this postulate, in this paper we shall agree to call real only that which is observer-independent.
- 2) This objective reality is, as Bergson put it, "what is perceived or perceivable" (Bergson, 1968) - if I perceive something, it is because this something is objectively out there, in reality, I didn't invent it. Therefore, as a rule (except in the case of hallucination, which is a sensory disorder) what I perceive is real.

The travelling twin's size having been exactly measured at his departure and again at his arrival, there is no doubt for the sedentary twin, who is a Naïve Realist, that it is real and that his brother has become shorter.

But for the travelling twin it is the opposite: he is entitled by Special Relativity to consider that he is at rest and that it is his brother who is moving, it is then his brother's time which is slowed down and his brother's lengths that are contracted, his own remaining unchanged. And as he is a Naïve Realist, he considers that his brother's shortened lengths are real.

But perhaps this shortening of lengths is not real after all, just apparent - i.e. illusory? But in this case, time dilation also would be only apparent and the entire Special Relativity would be illusory. Relativity makes clear that time dilation and length contraction happen for both twins, as a result of their relative movement. Length contraction is what each twin perceives and measures. If what is perceived is real, as assumed by Naïve Realism, it is real.

But if it is real, we have two opposite ontological realities here and not the one and all-encompassing ontological reality assumed by Naive Realism as its first postulate. Naive Realism is therefore in contradiction with itself.

Secondly, if two different observers perceive two different ontological realities, it means that there may be as many realities as there are observers. That we are not in a realistic world, but in George Berkeley's solipsistic world, where "esse est percipi", to be is to be perceived, where there is no objective observer-independent reality (Berkeley, 1957).

The only way out of this conundrum is to question Naive Realism - because it is not Relativity which asserts that time dilation and space contraction are real, it is Naive Realism.

It is worth noticing that the traveller's lengths are contracted only when viewed by his sedentary twin, not by himself - and the reverse. And if the traveller remains shorter when he is back on Earth, it is because he is not in his own reference frame, but in his brother's, where length contraction happened.

What each of the two brothers perceives depends not only on what reality is, but also on what he himself is, on the properties of his sensory apparatus and on the circumstances in which he uses it. But here, length contraction is one-sided, it occurs only for one observer at a time, not for both: it is observer-dependent, i.e. not real. It is a subjective perception, a subjective representation of reality.

Let us go farther: if the traveller's size is not real, the same is true for everything perceived: what each of us sees, hears, touches, etc., is objective reality *before* it is perceived. But *after* it has been perceived, it has become an abstract representation of reality, in the same way as when you photograph your cat your camera transforms it into a picture. You would not mistake your cat's picture for your cat, would you? Perception is then not reality but the observer's subjective interpretation of reality - its abstract image, an image which exists only in his consciousness (Gibson, 1987, Crane and French, 2021, O'Brien 2009). That several observers create a more or less identical image of the same object means only that they have a more or less identical sensory apparatus and are in a more or less identical relation with the object.

The shortened traveller's size is then not real, it is nothing else than his twin's representation of reality. Can we call it apparent? Yes - but on the condition that we also call apparent everything that we perceive. On the condition that we acknowledge that we perceive only *appearances* of the world - in Kant's language, *phenomenal* reality, not *noumenal* reality, not reality in itself. And then, there can be as many perceptions of the same reality as there are observers - not as many realities as there are observers.

Such a conclusion is counter-intuitive: we are naturally inclined to believe that what we see, hear, etc., is real.

This is due to the fact that our perception of reality is remarkably reliable and effective: it is the result of millions of years of evolution and it is the main instrument of our biological survival, the instrument through which we can know our environment, use its resources, avoid its dangers, in short, produce our existence. Therefore, we are naturally convinced that what we perceive is reality itself and we spontaneously reject the idea that it is only our subjective interpretation of it. And in fact, in ordinary life, we are all naive realists - this author included. All the more so since confusing what is perceived for what is usually doesn't lead to negative consequences. On the contrary, it is the efficient way perception is intended to work. This is why Naive realism could be the philosophical basis of classical physics for generations, to everyone's satisfaction.

But with the new horizons opened by modern physics, it has become obsolete. As shown, it does not permit to understand Relativity - the same being true for Quantum Mechanics. Hence an accumulation of paradoxes and unsolved problems that Naive realism fails to master.

This is why, in order to stay in step with the progress of physics, it is necessary to disengage from the old Naive Realism, inherited from classical physics in favor of a more elaborate form of realism.

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