# HOW I LEARNED TO STOP WORRYING AND LOVE THE INVERTED SPECTRUM

BY

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**Abstract:** It is possible for a person and their environment to be physically identical each day and yet the representational content of their beliefs about color are inverted. Each day they utter the same words, 'Wow! The colors of everything have switched again today.' In uttering these words, they express a different proposition each day. This supports the view held by Reichenbach and Carnap that when it comes to representations of colored objects, relations of similarity and difference are fundamental. There are no such things as colors like 'redness' and 'greenness' apart from the particular things we call red and green.

The inverted spectrum is sometimes used to argue that the subjective character of one's experiences does not supervene (either logically or naturally) on one's physical or functional state.[1] It is thus thought to present an obstacle physicalism and/or functionalism about the mind. More recently it has been used to argue for a robust distinction between the purely qualitative character of one's experiences and the representational content of one's perceptual experiences.[2] The representational content of two different perceptual experiences of looking up at the sky can be the same, but the qualitative content of the experiences might be different. Representationalists like Tye and Harman disagree. They deny that one's experiences have a qualitative content that is independent of the representational content of one's beliefs.[3] The believer in the inverted spectrum typically insists on their being an irreducibly qualitative character to our perceptual experiences of color. As a general rule, such philosophers are sympathetic to the idea that experience provides knowledge that cannot be gotten in any other way, for example, by reading books of neurology. Those who deny the inverted spectrum tend to disagree.

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It is my belief that the debates just mentioned obscure the key issues at stake in the inverted spectrum. It can be shown that a person and their surrounding environment can be physically the same on two occasions even though their perceptions of color are inverted. The content of one's perceptions of a clear blue sky at time t do not supervene on the physical state of the world at t. The inverted spectrum is empirically possible or so I will argue in this paper. However, the lover of qualitative experience should not take heart. When properly formulated, the inverted spectrum shows nearly the opposite of what philosophers typically think. It shows neither that qualitative content is independent of representational content nor that there is more to know about color than one can learn by studying neurology, but rather that colors, construed as universals, are not real. In judging something to be blue, one is simply classifying it as having the same color as other blue objects. This view of color was espoused by logical positivists like Reichenbach and Carnap.[4] Reichenbach argued that when one makes a judgment about the color of an object one sees, the content of one's judgment 'is just that there is a similarity between the present object and the one formerly seen.'[5] In other words, it is not the case that one has a grasp of yellowness and one applies this concept to a particular object, this banana. Rather one sees that one banana is the same with respect to color as another banana. In this paper I will adopt the point of view of a logical positivist like Reichenbach and argue the logical positivists' case. Some may balk at this because logical positivism is widely dismissed as no longer worthy of our time and attention. I disagree. In part the hostility to logical positivism comes from the misperception that it basically amounts to verificationism. This is unfortunate. Verificationism does not play nearly as important a role in logical positivism as is commonly thought. The emphasis on verificationism arose in part through the influence of an atypical logical positivist, A. J. Ayer.[6] Following Friedman and Livingston, I believe that structuralism is of central significance to the logical positivists.[7] It is more fundamental than verificationism and, as Livingston persuasively argues, is of much greater historical and philosophical significance than is generally recognized. Structuralism is a view about the meanings of our terms. Very roughly, it says that all meaningful claims can be translated into pure descriptions of relations. Carnap and Reichenbach argue that when it comes to the meaning of color terms, structure is fundamental.[8] This is the view that I will be arguing for on their behalf.[9] Structuralism about color is worthy of respect and serious consideration.[10] It is supported by the inverted spectrum thought experiment that I will present, which I call the logical positivists' inverted spectrum.

If the arguments in this paper are correct, then the positivists' inverted spectrum is much more of a threat to lovers of qualitative content like Chalmers than to empiricists like Dennett. This is nearly the opposite of what is usually supposed. All Dennett needs to do is to adopt a structur-

alist view of color. He can then use the positivists' inverted spectrum to argue against those who argue for the irreducibility of qualitative content.

## *1. Introduction*

To establish my thesis, I will present a person who is physically the same at one point in time and a day later. However, this person's perceptions of color will be inverted on the two occasions. Thus, I will present a case of an intra-subjective inverted spectrum. The notion of an intra-subjective inverted spectrum was popularized by Sydney Shoemaker who traces the idea to Wittgenstein.[11] Shoemaker describes a person, Fred, whose spectrum is inverted at one moment in time relative to how things appeared to Fred 30 years before and yet Fred is behaviorally the same now as he was 30 years before. At first when Fred's spectrum is inverted this makes a large difference in Fred's behavior, but over time the differences diminish. Eventually Fred forgets that his spectrum has ever inverted. My strategy will be different from Shoemaker's. The person in my thought experiment will not forget the past and yet the person will be physically the same as the person was before the spectrum inversion. To understand how this is possible it is absolutely crucial that we distinguish between one's physical state and one's representational state. Two people can be physically the same on two occasions and yet the semantic or representational content of what they believe on those two occasions can be quite different. For example, in his paper, 'A problem about continued belief,' Perry tells us that his older brother used to say to him each day, 'John, I'll give you a dollar tomorrow, but not today.'[12] Tomorrow would come around and the same empty promise would be made again. Each day John Perry's brother would utter the same words and in doing so would make a different claim with different truth conditions than the day before. That is, each day John Perry's brother would make a *different* assertion about what state of affairs will obtain. From this Perry concludes that just because the same words are asserted on two occasions this does not mean that the same thing is said. This is important and there are further implications. Imagine that the Perry brothers' lives are very dull and each day is the same as the day before. For example, each day they get up, do the same things, see the same things, and so on. Imagine that they lose track of the day of the week, the year, and their ages. We can imagine that there are a few mornings in which the Perry brothers are functionally the same and a description of their physical state on one morning would be an equally good description of their physical state the next. Nevertheless John Perry's beliefs each morning are different. Each morning he believes that *tomorrow* will be the day that his brother gives him a dollar, but *today* is not. Just because someone is in the same functional state on two occasions and a physical

description of them and their environment is the same, this does not mean that the person has the same beliefs or the same representational content. Sameness of physical state isn't enough to ensure sameness of representational state. I will show that something analogous holds for color beliefs.

We can distinguish between the physically individuated input and output from Perry's body, on the one hand, and the semantic or representational content of his input and output, on the other. The same physical impulses are transmitted from Perry's senses to his brain each day. Similarly, the same physical impulses are transmitted from Perry's brain to his muscles each day. Let us describe this by saying that the p-sensory input and p-behavior each day are the same. However, the representational content of what Perry discovers and his semantically interpreted behavior is quite different. Each day Perry learns a new fact and revises his beliefs and behavior accordingly. He uses the same words each day, but expresses a different belief, namely the belief that contrary to what he thought yesterday, he will not get paid today; he will have to wait until tomorrow. Let us describe this by saying that Perry's s-sensory input and s-behavior is different each day.

The positivist's inverted spectrum simply requires us to extend this thought experiment to beliefs about color. Perry will say things like, 'The color of the sky today is different from the color of the sky yesterday.' Perry and his environment will be physically the same each day. However, on our best interpretation, his perceptions of color will be different. What causes Perry's perceptions of color to shift will be the fact that aliens come to earth and tamper with his optic nerve so that blue light incident on his eyes leads his brain to receive the input that it would have received had he seen yellow light just before the aliens tamper with him.

In presenting Perry, I will argue for the following three claims:

*The Conceptual claim*: We can coherently describe a person, Perry, who has color vision and who sincerely utters things like 'The apparent color of the sky today is the same as the apparent color of the sky yesterday' because aliens tamper with his optic nerve inverting the color p-input to his brain, and yet his p-behavior and his dispositions to p-behave are the same each day.

*The Engineering Claim*: We can engineer Perry so that he acts as described in the conceptual claim and a physical description of him and his environment on one day is an equally good physical description of him the next.

*The Truth Claim*: When Perry says, 'The apparent color of the sky today is different from the apparent color of the sky yesterday' he speaks truly.

These three claims entail that a person can be physically the same on two days even though the color of the sky seems different to the person on the two days. This is the positivist's inverted spectrum and there is nothing

more mysterious about it than there is about the thought experiment with Perry.

Let us now consider the three claims.

## 2. *The conceptual claim*

I will now describe Perry and the context in which he lives. My claims are to be interpreted as applying to his p-input and p-behavior and physical environment. No claims about s-input or s-behavior will be made until section 4. This is important because it means that, no philosophical assumptions will be made until the very end. Even then, the philosophical assumptions made will be minimal.

Let us suppose that people are nearly immortal. Their physical bodies are replaced piece by piece with synthetic duplicates as they get older and decay. Still, their mental capacities, such as their memories, are not significantly enhanced. (We might suppose that there are laws against this.) As a result, for a person with a sufficiently dull life, each day might be qualitatively indiscernible from the day before. Imagine that one morning in this distant future when people wake up, they say that the colors of things seem to have switched. They say that the sky looks yellow; bananas look blue; trees have red leaves; and ripe strawberries are green. Let us suppose that what has changed to make them say this has a perfectly good scientific explanation. Aliens sneak down and install a device on peoples' optic nerves that alters the color information sent from the eyes to the brain. The device, called an inverter, takes the input from the eye and yields the information that the eye would have sent if the person had been not on earth, but on a planet just like earth only the colors of everything had been inverted: the sky is yellow; the trees are blue etc. Following Ned Block, let us call such a planet by the name 'Inverted Earth.'[13] At 8:00 a.m. a person's brain will be in the same state regardless of whether the aliens install the inverter or whether they instantly transport the person to the spot on Inverted Earth that (apart from differences in color) is qualitatively indiscernible from their location on Earth. This tampering with the optic nerve makes many functional differences, some obvious and immediate, some subtle and long term. In the short run, people are more likely to mistakenly drive through a red light and stop on a green light. In the long run, there are a variety of subtle effects on one's moods, emotions, and so forth.

Let us imagine that the shift happens every morning at 8:00 a.m. local time, and so people become accustomed to the changes. Each morning the aliens either install the inverters or remove them. Gradually the long-term psychological differences between colors diminish. The effect that yellow has on one's mood becomes no different from the effect that blue has on

one's mood. Let us suppose that eventually it is forgotten which color the sky was initially and which color lemons were initially and so on. Color terms like 'blue' and 'yellow' begin to fall out of use as colors are picked out demonstratively. People don't use the term 'blue' but rather terms such as 'the color of the sky today' or 'the color of bananas yesterday.' Let us also imagine that the different long-term associations of colors are weakened. Currently red and green have different associations: Red is associated with heat, danger, the devil, and the word 'red.' Green is associated with plants, pro-environmental politics, envy, and the word 'green.' These sorts of long-term associations fade away over time. There are still short-term associations. For example, people identify one color as the color of trees today and the other as the color of trees yesterday. But people no longer say that one color (the color of trees or the color of strawberries) is more closely associated with danger than the other. The colors are much more interchangeable in the future world I am describing than they are for us. Let us suppose that eventually a certain sort of symmetry between the colors is established: no two complementary colors have qualitatively different psychological effects or long-term associations. For example, it is not the case that on some days, trees seem normal and on other days, their color brings to mind danger and Hell. At this point, people can still discriminate between colors. For example, an apple is easily spotted on a tree because its color differs from the color of the leaves; but there are no differences in how people p-behave one day and how they p-behave the next. In other words, a physical description of their p-behavior one day is an equally good physical description of their p-behavior the next day. Each day at 8:01 a.m. people say, 'Gosh . . . the colors of things look different again.'

Let us suppose that psychological experiments are performed on certain people constantly to monitor the changes. Let us suppose that Perry is one such person. Perry is repeatedly shown color-coated cards with different numbers on them and he is asked to group the cards on the basis of their apparent color. So, for example, he is shown one red card (labeled one); then after this card is taken away, he shown another red card (labeled two); then, after card two is taken away, he is shown a green card (labeled three). If the aliens tamper with him after he sees card one, but before he sees cards two and three, then he will say that cards one and three are the same color, but card two is of a different color. The approximate time of the change in Perry can be determined by such experiments. In essence, we can diagnose Perry by noting anomalies in his diachronic judgments of sameness of color.

I will now introduce two definitions and a claim. For the purpose of this paper, let us stipulate that the word 'brain' does not include Perry's optic nerves. Let us define 'black box functional state' so that Perry is in the same black box functional state on two occasions if and only if given the

same sequences of p-sense input on the two occasions, he p-behaves identically. Let us consider a ten-day period long after colors have lost their long-term associations for Perry. Perry's p-input and p-output has been the same each day for well over forty years. Call this the Ten-Day Stretch. Here is what I call the conceptual claim:

*The Conceptual Claim*: If we add enough detail to the description of Perry in section 2, we can ensure that Perry is in the same black box functional state at any given time on any given day in the Ten-Day Stretch as he was in 24 hours earlier. The description of Perry in section 2 says two things of particular relevance to us: 1) All p-behavioral evidence suggests that Perry's perceptions of colors invert each day at 8:00 a.m. 2) This is because aliens tamper with Perry's optic nerves at 8:00 a.m. each day so that the p-input to his brain is precisely what it would have been if instead of tampering with him, the aliens had transported him to Inverted Earth. The aliens do not tamper with Perry's brain or his memory, just his optic nerve.

The conceptual claim might be met with an objection: What the aliens did to Perry makes an important physical and functional difference. His functional state is different because the aliens tamper with him. So how can it be that he is in the same black box functional state on two consecutive days? Here is my response: There is no contradiction in saying that what the aliens do to Perry makes a functional difference and saying that Perry is in the same black box functional state on two consecutive days. Both can be true. We are supposing that Perry's life is very dull; each day is virtually identical to the one before. Perry can, of course, remember what happened for quite a few days. Unfortunately, the days are so similar that there are no differences to remember except for the differences involving color. Every second day seems the same to him and has for as long as he can remember. What are we to say about the difference between his life on one day and the next? The words that come out of Perry's mouth in response to a given stimulus on one day will be the same as the words that come out of his mouth 24 hours later in response to a similar stimulus. For example, one hands Perry a green note card at 8:01 a.m. each day and in each case he says, 'That's the color of strawberries. . . . No! . . . Wait! . . . That's the color that the leaves of trees are today. I forgot that I just had my spectrum inverted.' He will say this because a card we call green (but he would not) will always appear to him to be the same color as the leaves; this is true every day. But it may also be true that at 8:01 a.m. every day he will be inclined to make mistakes about colors and mix up colors with their complements because his optic nerve has just been tampered with by the aliens and he has not yet adjusted completely. Each day he will think for an instant that a green card is the color of strawberries. Each morning he will sincerely say that his spectrum has just been inverted and that things look different from how they looked one day ago. In all cases he will be fully capable of discriminating between colors.

## 3. *The engineering claim*

We now need to ensure that Perry is physically the same each day. So far we have limited ourselves to discussing the connections between Perry's p-sense input and p-behavioral output. We have shown that he is in the same black box functional state every day of the Ten-Day Stretch at 8:01 a.m. But this is consistent with his being in rather different physical states each day. In this section we will, for the first time, consider the inner workings of Perry's brain. We will say something about how he is designed. Our goal here is simple. We must show that it is possible in theory to engineer Perry without violating the conceptual claim in such a way that a physical description of him and his environment on one day of the Ten-Day Stretch is an equally good physical description of him and his environment the next day of the Ten-Day Stretch. We call this the engineering claim. Notice that whether or not the engineering claim is true is purely an engineering question. It has no philosophical content and does not depend on any assumptions about the semantic content of Perry's claims or the representational content of his mental states.

In order to formulate the engineering claim, it will help to introduce some technical terminology. Let us say that a system is *physically indiscernible* on two occasions if and only if a purely qualitative description (i.e., a description that makes no reference to token particulars) of the physical state of the system on the first occasion would also apply to the system on the second occasion. Thus the only potential differences would involve token particulars. We could switch around all the molecules in the system and, so long as a purely qualitative description of the system is the same, the system will be physically indiscernible as I am using the term. We can contrast being physically indiscernible with being physically identical. For a system to be physically identical on two occasions, the system must be physically indiscernible and also the same token particular molecules, neurons, etc. must play the same roles and be in the same places. The engineering claim can be put more carefully as follows:

*The Engineering claim*: Consider the sequence of black box functional states Perry is in over the course of the Ten-Day Stretch. Suppose that the conceptual claim is true and each of the black box functional states that happen on the first day repeat again on the second, the third, and so on. It is possible to engineer Perry so that he is physically indiscernible and functionally the same on each day of the Ten-Day Stretch.

Before I explain how to construct Perry's brain and optic nerve so the engineering claim is true, I will make some observations. I presume that given the symmetry of the situation, given any moment t during the Ten-Day Stretch it is perfectly possible for Perry to be physically indiscernible at t and 48 hours earlier at t-48 hours; after all Perry is in the same representational state and the same black box functional state on both

occasions. Suppose that Perry has a twin brother, Jason, who at any given moment is physically indiscernible from Perry 24 hours earlier. Consider for a moment a person whose body contains the brains of both Perry and Jason such that both brains work in parallel and are connected to all the same afferent and efferent nerve endings. By the conceptual claim we know that for any moment t during the Ten-Day Stretch, Perry is in the same black box functional state he was at t-24 hours. Therefore, at any given moment t of the Ten-Day Stretch Perry and Jason are in the same black box functional state. This means that their brains can both be 'hooked up' to the same body without interfering with each other. Dennett describes something analogous to this in his story 'Where am I?'[14] Furthermore, if we are careful we can set things up so that for any moment t in the Ten-Day stretch, the combined system, that is, the body with both brains in it, is physically indiscernible at t and at t-24 hours. Here is how we do it. Suppose that at t Perry's brain is on the left and Jason's brain is on the right as illustrated in Figure 1.

There are inverters on both of Perry's optic nerves but not on Jason's optic nerves. Let us suppose that every 24 hours the aliens detach Perry's brain from its optic nerves and Jason's brain from Jason's optic nerves. They then place Perry's brain where Jason's brain was and vice versa. They then reattach the two brains so that now the brain which wasn't attached to the optic nerves with the inverters now is and vice versa. If we thought of Perry as the combined system then the conceptual claim would hold.

The trick to designing Perry is to set him up so that in effect his brain is a composite of the two brains which we have 'smushed' together. I will now explain how we do it.

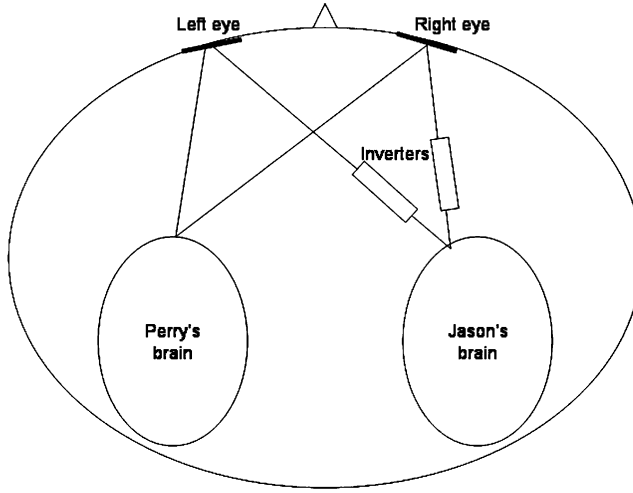


**Figure 1**

Let us suppose that Perry's brain has two distinct parts, the top part and the bottom part. All communication to and from the top part of Perry's brain happens by remote control. His sense organs transmit messages that are picked up by a little antenna on the top part of Perry's brain. The top part of his brain transmits signals to his muscles and glands. If the bottom part of his brain were not functioning properly, Perry would lose his capacity for color vision and this is all he would lose. This is because the only cognitive activity in the bottom part of his brain is the processing and transmission of color information.

Let us suppose that the bottom part of Perry's brain is very simple. It is composed entirely of a string of bits arrayed in a vertical column along the vertical axis of Perry's brain. Let us suppose that optic nerves attach Perry's eyes to the bottom part of his brain. They are made out of a large number of distinct tendrils, each one of which attaches to a distinct bit in the bottom part Perry's brain. At any given moment, a given tendril can be in one of two states, + and −, and the bit it is attached to will be in a corresponding state. In essence, each tendril transmits a single bit of information to a single bit in the lower part of Perry's brain. Suppose that there are n tendrils and many more than n bits. We will suppose that the top n bits each has a single tendril attached to it as indicated in Figure 2 below.

For the sake of simplicity, let us suppose that Perry receives a single discrete signal from his optic nerves every $1/10^{th}$ of a second. Each $1/10^{th}$ of a second the top n bits transmit their state to the bits n below them. In

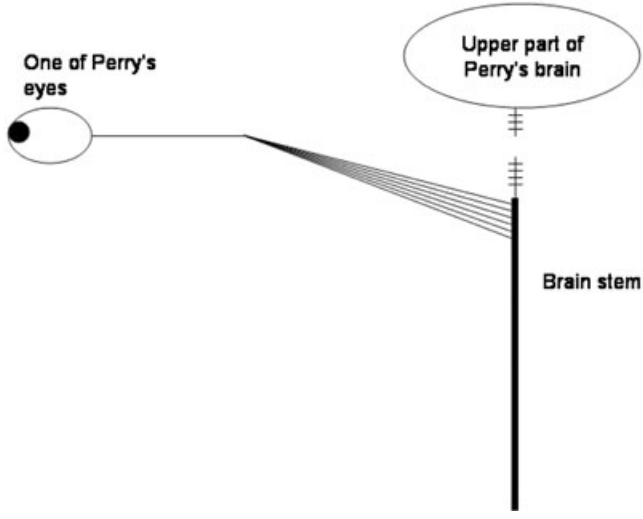


**Figure 2**

other words, at any given time t, bits n + 1 through 2n will be in exactly the same state as the top n bits were at t – 1/10th of a second. The same is true for the next n bits and so on down the line. Memory extends for 30 years. After 30 years, color memory is purged. In other words, the information in the bottom n bits is lost 10 times a second. Perry's memories cascade down the axis of his brain like the bands on an old fashioned barber's pole.

Each bit in the bottom part of Perry's brain transmits information to the top part of his brain. A bit sends one signal if it is in the same state as the bit n below it and a different signal if it is in a different state from the bit n below it. In this way, and only in this way, the bottom part of Perry's brain transmits information about colors to the top part. Notice that the bottom part transmits only information about the *relative* states of the bits in the bottom part. This means that the top part of his brain has only *relational* information about colors, such as the fact that the color related p-input incident on Perry's brain today is the precise inverse of the color related p-input the day before.

Let us suppose that each tendril from Perry's optic nerve splits in two; one end attaches to one side of a bit and the other side attaches to the other side of the bit. Each tendril to the right side of Perry's bit has a little device called an 'inverter' on it. The inverter converts a+ into a– or vice versa. Thus if a tendril is stimulated by the eye into a+ state, it will transmit a+ to the left side of the bit it is attached to and a– to the right side of the bit it is attached to. It is never the case that a tendril will simultaneously transmit a+ to both sides.

When the aliens tamper with Perry's brain, they detach all his tendrils, rotate the bottom part of his brain by 180 degrees about the vertical axis, and reattach his tendrils. This should have no effect on Perry's p-behavior at all if he were to keep his eyes closed. However, as I will now explain, if he were to open his eyes, his p-sense input incident on the top n bits in the bottom part of his brain would be inverted with respect to what they would have been otherwise. Let us suppose that each bit is shaped like a small oblong box with one end of the box facing to Perry's right and one side facing to Perry's left. (This means that the long side of each bit is perpendicular to the vertical.) Within each box is a single rectangular bar shaped magnet. The positive end of the magnet can either face Perry's right side or his left side. These constitute the two different states the bit can be in. See Figure 3, which is a horizontal slice of the bottom part of Perry's brain.

Each bit in the bottom part of Perry's brain (except for the last n bits) has two wires that go directly to the bit n below it. One wire attaches to the left side of the bit and goes to the left side of the bit n below. The other wire attaches to the right side of the bit and goes to the right side of the bit n below. These wires each connect to a simple logic chip and radio transmitter. (Each connects to its own logic chip and its own radio transmitter

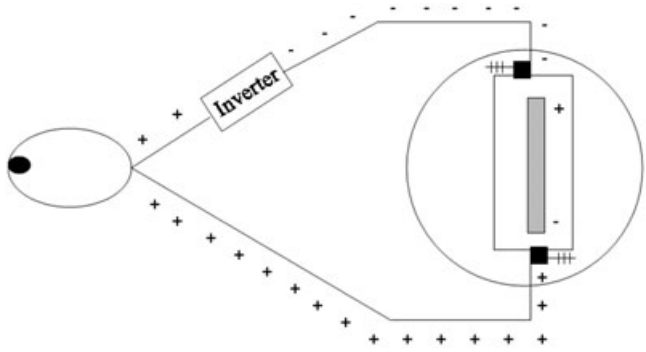


**Figure 3**

as indicated in Figure 3 above.) If there is a positive charge at both ends of the wire or a negative charge at both ends of the wire then one particular message is transmitted by radio transmitter to the top part of Perry's brain. Otherwise, 1) a different message is sent and 2) at the end of the current $1/10^{th}$ of a second long input interval, a signal is sent to the bit n below that causes it to switch its state. If Perry's bits are constructed as just described then we can (and we do) design him so that if we rotate this column of chips by 180 degrees about the vertical axis, the only difference in our description of him will be in the direction in which the positive ends of the magnets point. They will all be reversed. Otherwise, a description of him will be the same.

Our description of Perry is now complete. Provided that we design him so that he has the symmetries just specified, a description of him one day will be an equally good description of him the next. For example, if on a typical day of the Ten-Day stretch 10 minutes after the aliens tamper with Perry, his top most bit has its positive side pointed to the right then the same will be true 24 hours later because the aliens will have rotated his lower brain by 180° and also switched which side of each bit has the tendril with the inverter. The two cancel each other out. Something similar happens for bits below the first n bits. An arbitrary bit in the middle of the bottom part of Perry's brain is the same as the bit n above it $1/10^{th}$ of second earlier. So if the top n bits in Perry's brain are in the same state each day, so are the next n bits and so on down the line. Other than a potential difference in the directions in which the bar magnets point, the bottom part of Perry's brain looks the same regardless of whether or not it is rotated by 180°. Therefore, Perry can be designed so that the engineering claim and the conceptual claim are both true.

We have basically designed Perry so that 1) he is sensitive to similarity and difference in colors he sees and 2) he classifies his perceptions of color indexically on the basis of how they relate to his past perceptions of color.

In other words, all other things being equal (and they always are at the same time on any two days during the Ten-Day Stretch), a description of Perry at a given moment is a function of the diachronic structure of similarities and differences in colors he has seen. But this structure is the same each day, which is why Perry is physically indiscernible each day. Recall that Perry's descriptions of the colors he sees take the following form: 'The color of the sky today is the same as the color of bananas yesterday but different from the color of the sky yesterday.' We have given Perry all he needs to make his p-behavior as described in the conceptual claim.

## *4. The truth claim*

I will now make my first and only interpretive claim, the truth claim. This is my only claim about Perry's s-behavior. The previous two claims were merely claims about Perry's physical state.

*The Truth Claim*: When, at 8:01 a.m. of the fifth day of the Ten Day Stretch, Perry says 'The apparent color of the sky now is different from the apparent color of the sky yesterday,' he speaks truly.

Here is my argument for the truth claim:

By the conceptual claim, we know that the aliens tamper with Perry's optic nerve, not directly with his brain itself. As a result regardless of whether the aliens tamper with Perry in the usual way or whether they invert the colors of the things he sees (for example by instantly transporting him to Inverted Earth), the resulting physical state of his brain will be identical. If Perry's brain is identical in two possible scenarios and if his perceptions of color suddenly invert in one of the scenarios then they invert in the other scenario as well. Clearly if the aliens invert the colors of the things Perry sees by placing him on Inverted Earth, Perry's perceptions of colors will change. Therefore if the aliens tamper with Perry in the usual way, his perceptions of color change. The truth claim follows.

The aliens tamper with Perry's optic nerve so the information about colors that is sent to Perry's brain is inverted with respect to what it had been just before the aliens tampered with him. This is why Perry confuses colors. This is a paradigmatic example of exactly what you would do to someone to invert the person's spectrum. The aliens do not muck about with Perry's brain, just his optic nerve (which inverts his spectrum) and the orientation of his brain in his skull (which does not change his mental states).

There is a great deal of additional evidence in favor of the truth claim. Such evidence includes many of Perry's actions, such as his assertions that the colors of things seem to have changed, and the psychological experiments performed on him.

Notice what the truth claim does not say. The truth claim does not say that Perry has qualia or that his experiences have qualitative content. The truth claim does not even say that there is such a thing as the feeling of what it is like for Perry to see colors. Let us suppose that other than his strange visual system, Perry has normal perceptual systems. Surely he is capable of making true claims and inferences on the basis of the colors of the things he sees. The truth claim says little more than this.

## 5. *Argument*

If the truth claim is true then the apparent color of the things Perry sees at 8:01 a.m. on any given day in the Ten Day Stretch are different from the apparent color of the things Perry saw 24 hours before. But if the engineering claim is true, then he is physically indiscernible at 8:01 a.m. on one day and the next. Thus, Perry provides us an empirically possible example of an inverted spectrum. This looks like a *prima facie* problem for any theory that tells us that in order for the apparent colors of things to be the same for a person on two days it suffices for the person to be physically indiscernible on the two occasions. We can strengthen the thought experiment so that Perry is physically identical on the first day and the tenth day of the Ten-Day Stretch.

Suppose that Perry has a fast metabolism and his cells are broken down and rebuilt from new matter every day. Suppose that in a mere four days it is possible that all of the matter that constitutes Perry can be eliminated and replaced with new matter. Suppose that in 5 days Perry can ingest the old matter and so his physical state can be identical to what it was 9 days before. There is no reason why Perry on the tenth day of the Ten-Day Stretch cannot be physically identical to Perry on the first day of the Ten-Day Stretch. This contradicts nothing that was said above. Yet, if the claims above are correct then Perry's perceptions of color are different on the first day of the Ten-Day Stretch and on the tenth day of the Ten-Day Stretch. If four days seems too short a period of time for all of Perry's matter to be replaced by new matter then we can make the Ten-Day Stretch a Hundred-Day Stretch or even a Thousand-Day Stretch. The point is simply that nothing said above precludes the fact that Perry can be physically identical on two days that are an odd number of days apart. This means that Perry can be physically identical on two occasions even though his perceptions of color are different.

## 6. *Objections to the positivists' inverted spectrum*

The argument just given shows that a person can be physically identical on two occasions (and in a physically identical environment) and yet the

representational content of the person's perceptions of color can be different on the two occasions. One might try to argue that Perry doesn't *really* see colors; he merely has the capacity to discriminate between them. *Our* perceptions of color at time t are fixed by the instantaneous state of the world at t. Perry's are not. Therefore Perry does not have representational content of colors. I don't find this move very convincing. Perry has fully functional color vision. He can look at an apple tree and distinguish the red apples from the green leaves by their differing colors. This move is not going to be open to most empiricists like Dennett or representationalists like Tye. But even for a qualia-lover there are problems. Perry's brain is normal except for how he processes color input. He has conscious beliefs and conscious experiences of tastes and smells. He thinks he has conscious beliefs about colors. Does it make sense to suppose that in fact he is incapable of forming beliefs about colors? This seems absurd.

Let's consider some other arguments against the positivists' inverted spectrum. Some have argued against the inverted spectrum on the grounds that it is empirically impossible for our spectrums to be inverted because our color space is not symmetrical. For one's spectrum to be inverted it must be possible to map each of the colors one perceives onto a corresponding color in such a way that all relations of relative similarity and difference between colors are preserved. This seems unlikely because we experience some colors, such as red and blue, as having many more shades than other colors. Our color space is asymmetrical and not capable of being inverted.[15] A common response to this, which I have taken in this paper, is to argue that even if, as a matter of contingent empirical fact, the inverted spectrum is not possible for us as we actually are, still, it would be possible for us if our visual systems were a little different and had the relevant symmetries. Philosophers like Block and Shoemaker argue that physicalism and functionalism are supposed to apply not only to actual people, but at least to all empirically possible beings who have visual experiences.[16] Some who don't think the inverted spectrum is possible have argued that there is no logically possible (and a fortiori no empirically possible) color space that is capable of being inverted.[17] For example, Hilbert and Kalderon argue 'It is conceptually necessary that the identity of perceived color is given by position in the color space.'[18] Dennett makes a similar claim. He disputes Shoemaker's assertion that even if we don't have symmetrical color spaces some creature could:

> What *anchors* our naive sense that there are such properties as qualia are the multiple, asymmetrical, interdependent sets of reactive dispositions by which we acquaint ourselves with the sensible world. Our sense that the color red has, as it were, an identity, a 'personality' all its own is *due* to the host of *different* associations that go with each color. Shoemaker's

envisaged creatures, lacking all such reactive landmarks in their dispositional make-up, would not think that they had qualia at all – what is was like to have one sort of experience would not differ at all from what it was like to have a different one.[19]

Unfortunately, this objection is a non-sequitur when applied to the positivists' inverted spectrum since in the positivists' inverted spectrum the representational content is inverted and there is no mention of qualia at all. It gives us no reason at all to question any of the three assumptions in the argument, nor does it give us reason to question the argument's validity. The positivists' inverted spectrum contradicts Dennett's claims by showing that color space can be inverted. I think Dennett's best response to this argument is to embrace its anti-Cartesian pro-logical positivist implications. I will explain. From the perspective of a logical positivist like Carnap or Reichenbach, contemporary philosophical questions about what constitutes the identity of our experience of color are cognitively meaningless. Dennett unnecessarily presupposes that colors are universals. He presupposes that each color corresponds to a distinguishing description, a 'host of *different* associations . . . go with each color' as Dennett says in the quote above. Against this, a philosopher like Reichenbach would argue that there is no such thing as a monadic predicate blue which can, in general, be abstracted from the particular token objects that we judge to be blue. *Differences* between colors are more fundamental than the colors themselves. That is, in judging something to be blue, I am simply judging that it differs in its color from something that I judge to be yellow. There is nothing, such as blueness, which can be abstracted from the process of perception and from all particular cases of seeing color. As a result, contrary to Dennett's claims, we should not expect to be able to give a distinguishing qualitative description of blue-seeing-experiences that differentiate them from yellow-seeing-experiences. To put this point another way, the empiricist should admit that we cannot learn what blue is like from reading books about neurology. This is not because facts about blue are non-physical, but because *there is nothing to learn*, no fact about what blue is, apart from the particular facts about which particular things we happen to classify as blue.

Rather than disagreeing with Shoemaker directly, empiricists like Dennett would be better off if they were to reject Shoemaker's assumption that when it comes to color identity is more fundamental than difference. Once they have done this they can stop worrying about how each color can be paired with a purely structural/functional description. In effect, rather than trying to solve the hard problem, the empiricist should deny that there is any hard problem to be solved. For example, they should deny that Mary the neurosurgeon has anything to learn when she learns about the identity of each of the colors.[20] There only seems to be a problem so long as we accept the intuition that colors are universals, that is, only so long as

we think it makes sense to distinguish a color type (e.g., blue) from all particulars.

The positivists' inverted spectrum is not a problem for the empiricist, but for the lover of qualia, for it is the lover of qualia who is committed to the Cartesian notion that a color experience has an identity that can be abstracted from any particular token event in time and space. By giving up this view, the empiricist can learn to love the inverted spectrum.[21]

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NOTES

[1] For example, see Shoemaker, S. (1982). "The Inverted Spectrum," *Journal of Philosophy*, 79, pp. 357–81; Block, N. (1990). "Inverted Earth," in J. Tomberlin (ed.) *Philosophical Perspectives* 4. Northridge CA: Ridgeview Publishing Company; Block, N. and Fodor, J. (1972). "What Psychological States Are Not," *Philosophical Review* 81, pp. 159–181; and Chalmers, D. (1996). *The Conscious Mind*. Oxford: Oxford University Press.

[2] For example, see Block, N. (2003). "Mental Paint," in M. Hahn and B. Ramberg (eds.) *Reflections and Replies: Essays on the Philosophy of Tyler Burge*. Cambridge, MA: MIT Press; and McIver Lopes, D. M. (2000). "What Is It Like to See with Your Ears? The Representational Theory of Mind," *Philosophy and Phenomenological Research* LX, pp. 439–453.

[3] For example, see Harman, G. (1990). "The Intrinsic Quality of Experience," *Philosophical Perspectives* 4, pp. 31–51; Tye, M. (1995). *Ten Problems of Consciousness: A Representational Theory of the Phenomenal Mind*. Cambridge, MA: MIT Press; and Tye, M. (2000). *Consciousness, Color and Content*. Cambridge, MA: MIT Press.

[4] Reichenbach, H. (1938). *Experience and Prediction*. Chicago, IL: University of Chicago Press, pp. 176–177. Also, Carnap, R. (1928). *The Logical Structure of the World*, R. A. George, trans. La Salle, IL: Open Court, pp. 122–132.

[5] Reichenbach, 1938, p. 176.

[6] For example, see Ayer, A. J. (1952). *Language, Truth, and Logic*. New York: Dover Publications.

[7] Friedman, M. (1999). *Reconsidering Logical Positivism*. Cambridge: Cambridge University Press; and Livingston, P. (2004). *Philosophical History and the Problem of Consciousness*. Cambridge: Cambridge University Press.

[8] Reichenbach, 1938; Carnap, 1928.

[9] This paper is not written in my own voice. I am arguing on behalf of Carnap and Reichenbach since they are not here to do so.

[10] It is not given adequate respect today. For a history of how this came to be see Scholette, T. (2008) "The Shocking Non Sequitur," *International Philosophical Quarterly* Vol. 48, no. 4, issue 192.

[11] For example, see Shoemaker, 1982, pp. 357–81.

[12] Perry, J. (1980). "A Problem About Continued Belief," *Pacific Philosophical Quarterly* 61, pp. 317–332.

[13] Block, 1990.

[14] Dennett, D. (1981). "Where Am I?" in *Brainstorms*. Cambridge, MA: MIT Press.

[15] Hardin, C. L. (1997). "Reinverting the Spectrum" in A. Byrne and D. Hilbert (eds.) *Readings on Color*. Cambridge, MA: MIT Press.

[16] Shoemaker, 1982, pp. 357–81; Block, 1990.

[17] Hilbert, D. R. and Kalderon, M. E. (2000). "Color and the Inverted Spectrum" in S. Davis (ed.) *Color Perception: Philosophical, Psychological, Artistic, and Computational Perspectives*. Oxford: Oxford University Press; Dennett, D. (1993). "The Message Is: There Is No Medium," *Philosophy and Phenomenological Research* 53, p. 927; Harrison, B. (1973). *Form and Content*. Oxford: Basil Blackwell.

[18] Hilbert and Kalderon, 2000, p. 202. They consider the inverted spectrum as an objection to intentionalism, for example, as espoused by Harman (1990).

[19] Dennett, 1993, p. 927.

[20] Jackson, F. (1982). "Epiphenomenal Qualia," *Philosophical Quarterly* 32, pp. 27–36.

[21] I am thankful to Moira Gilruth from *Philosophical Quarterly*, Strefan Fauble, Jason Ford, and Paul Livingston for their feedback on this paper.