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PERCEPTUAL KNOWLEDGE DERAILED

(Received in revised version 31 July 2002)

ABSTRACT. The *tracking theory* treats knowledge as counterfactual covariation of belief and truth through a sphere of possibilities. I argue that the tracking theory cannot respect perceptual knowledge, because perceptual belief covaries with truth through a discontinuous scatter of possibilities. Perceptual knowledge is subject to *inner derailing*: there is an inner hollow of perceptual incompetence through which the differences are too small to track. Perceptual knowledge is subject to *outer derailing*: there are outlying islands of perceptual competence that extend well past skeptical sinkholes.

Knowledge, according to the *tracking theory* (Nozick, 1981; DeRose, 1995; Heller, 1999), is counterfactual covariation of belief and truth through a sphere of possibilities. I argue that the tracking theory cannot respect perceptual knowledge, because perceptual belief covaries with truth through a discontinuous scatter of possibilities. The tracking theory misrepresents our perceptual competence.

1. TRACKING

Suppose *s* has a true belief that *p*. Here truth and belief coextend. What needs to be added to true belief to yield knowledge?

According to the tracking theorist, what needs to be added to true belief to yield knowledge is a range of counterfactuals on which the truth of *p* covaries with *s*'s belief in *p*. These counterfactuals range through an actuality-centered sphere of possibilities *L*, and say that, for every possibility *w* in *L*, *s* believes *p* at *w* iff *p* is true at *w*. Thus the tracking theorist proposes:

> *s* knows that *p* iff (1) *p* is true, (2) *s* believes that *p*, and (3) for every possibility *w* in the sphere *L*, *s* believes that *p* at *w* iff *p* is true at *w*.[1]

Tracking theorists may debate the proper radius of *L*. On Nozick's original version, *L* radiates out to the nearest $\sim p$-world.[2] On DeRose's and Heller's contextualist versions, *L* radiates at least to the nearest $\sim p$ world, and out to any farther contextually relevant world. For present purposes it suffices to note that *L* must extend to at least one $\sim p$ world. Such is the minimum needed to test whether *s*'s belief is *sensitive* to the falsity of *p* (Nozick, pp. 175–176; DeRose, pp. 24–26).

Tracking theorists may also add various epicycles. Nozick and DeRose add that one must hold *s*'s method of belief-formation fixed (or regard sameness of method as a highly salient respect of similarity). DeRose allows that still further epicycles might be needed, and claims only that the tracking theory is "at least roughly correct" (p. 25) For present purposes I would just say that *if* there are clear cases of perceptual knowledge in which (i) *s*'s method is held perfectly fixed, but for which (ii) systematic failures of tracking arise, then this is reason to believe that the tracking theory is not even roughly correct.

Tracking theorists may also replace condition (3) with any of many alternatives. Whether there is some alternative condition (3′) that might resolve the problems discussed below is not a question I know how to address, and whether the resulting theory would still deserve the label "tracking" is not a question I know how to decide. For present purposes I would just say that the argument that follows is targeted, strictly speaking, at *any account of knowledge that requires counterfactual covariation of belief and truth through a sphere of possibilities extending from actuality out to at least one $\sim p$-world*.

2. PERCEPTION

Suppose that Percy the normal human perceiver sees Sextus the six-footer, and Percy forms the true belief that *p*: Sextus is six feet tall. Consider various counterfactual alterations to Sextus' height. At which of these possibilities would Percy notice the difference?

First, consider those worlds in which Sextus is a mere millimeter taller (or a mere micrometer taller, or a mere nanometer taller . . .).

Percy would fail to notice the difference, because it is too small for him to detect.

In general, human perception is only accurate within a *margin for error*. Our perceptual mechanisms for vision, hearing, taste, etc. are all imperfectly calibrated. In psychophysics, perceptual margins for error are known as *j.n.d.* (just noticeable difference) principles. These are described by Weber's law, due to G. T. Fechner in 1860. Weber's law is: $\Delta S/S = K$, which states that the size of a noticeable difference in stimulation is a constant proportion of the existing stimulus. For instance, j.n.d.'s in tonal frequency (at least for the central portion of the human range) are well-described by K = 0.0025. Thus if the existing stimulus S is 1000 Hz, then differences up to ± 2.5 Hz will not be noticeable (Watson, 1973).

Second, consider those worlds in which Sextus is a full foot taller (or a full yard taller, or a full mile taller . . .) Percy would notice this difference, because it is too big for him to miss.

In general, human perception may still function in some very far-flung regions of logical space, including worlds in which Sextus is a full mile taller, or has been transformed into an octopus the size of Africa. Our perceptual mechanisms might still function perfectly at such worlds. What is important to note about some of the more far-flung of these worlds is that, on any reasonable construal of "nearness", there are skeptical scenarios such as dreaming scenarios nearer-in. Dreaming is an every-night affair; mile tall men are in a different league.

These considerations suggest the following picture of human perceptual competence. There are (1) inner hollows of near-in changes that we cannot discriminate (millimeter differences), (2) outer islands of far-flung changes that we can discriminate (mile differences), with (3) skeptical sinkholes (dreaming scenarios) in between. *The possibilities that we can discriminate are not clustered in logical space*. The logical topology of perceptual competence is that of a discontinuous scatter rather than a sphere.

In what follows I elaborate on this picture of human perceptual competence, and argue that this picture refutes the tracking theory (§1).

3. INNER DERAILING, PART I: PRECISE BELIEF

Can the tracking theory respect perceptual knowledge? I argue that the tracking theory is in trouble at both (1) the inner hollow of near-in changes that we cannot discriminate between, and (2) the outer islands of far-flung changes that we can discriminate against. I call the first sort of trouble 'inner derailing', and the second sort 'outer derailing'. In this and the next two sections (§s 3–5) I discuss inner derailing, and in the section thereafter (§6) I discuss outer derailing.

The tracking theory derails at the inner hollow of near-in worlds that we cannot discriminate between. Take any paradigmatic case of perceptual knowledge. Suppose, to continue the previous example, that Percy the perceiver sees Sextus the six-footer, and forms the true belief that p: Sextus is six feet tall. Flesh out the details in the least problematic ways: Percy is awake, alert, undrugged, and otherwise undeceived; the lighting and other conditions are optimal; Percy is a trained judge of height; he forms his belief that p on the basis of what he sees and not by guessing; etc. Here Percy knows that p. Or at least, if human perception can ever generate knowledge that p, this should be understood as such a case. So I would expect the tracking theorist to insist. (Similar considerations should apply whenever someone sees powder blue, hears a b-sharp, etc.)

But does the tracking theory (§1) respect the verdict that Percy knows that p? Since Percy has a true belief by supposition, conditions (1) and (2) of the theory are met. But is condition (3) met? Is it the case that, for every possibility w in the actuality-centered sphere of worlds L, Percy believes that p at w iff p is true at w? I maintain that the answer is: *no*.

Discussing condition (3), however, proves tricky. One needs at least some sense as to how to answer three questions. First, what is the radius of L? In other words, how far out in logical space must Percy stay on track? Second, what is the similarity metric? In particular, given that L radiates out to $w1$, what factors determine whether or not L includes $w2$? In other words, what factors determine whether or not $w1$ is nearer to actuality than $w2$? Third (the tricky part), what is the content of the belief that p? In other words, what is the extent of the p-worlds?

As to the first question of the radius of L, I assume only that L includes at least one $\sim p$-world (§1). If there exists a nearest $\sim p$-world $w1$, then L radiates from actuality out at least to $w1$.

As to the second question of the similarity metric, the notion of similarity appropriate to counterfactuals is well enough understood for present purposes. On the Stalnaker-Lewis semantics for counterfactuals, similarity is a largely intuitive notion. I rely on the following intuitive principle: *ceteris paribus*, if $w1$ and $w2$ differ from actuality in respect r only, and $w1$ differs from actuality r-wise less than $w2$ does, then $w1$ is at least as near to actuality as $w2$ is. This principle has exceptions in exceptional cases.[3] This principle is highly idealized even in mundane cases.[4] But I think it is plausible enough, and applicable enough, for the purposes at hand. So *ceteris paribus*, a world in which Sextus differs from actuality by $1/16''$ is at least as near as a world in which Sextus differs by $1/4''$.[5]

The third question of the content of p is the tricky question. The difficulty is how to factor in the *vagueness* of contents such as *that Sextus is six feet tall*. This is a difficulty which is general to any perceptual content, and which tracking theorists have yet to offer help with (in this respect extant versions of the tracking theory are crucially incomplete). I proceed as follows. First (in what remains of this section) I consider a simple, albeit extreme, rendering of the content of p as perfectly precise. On this precise rendering, the p-worlds are all and only those worlds in which Sextus is *precisely* $6'$ tall. I show that inner derailing afflicts precise belief. Second (§s 4–5) I consider the plausible ways of relaxing the precise rendering of the content of p by invoking vagueness and by invoking intervals, and show that the inner derailing remains.

So with (i) L understood to radiate out to at least one $\sim p$-world, (ii) the similarity metric understood to be ordered by height differences, and (iii) p rendered as perfectly precise (on the simple but extreme rendering I am currently working with), I am finally in position to apply the tracking theorist's condition (3). Which possibilities are in the tracking sphere L? If a fine-grained similarity metric is in play, then there will be an infinite sequence of ever-nearer $\sim p$-worlds: $6'+1/2''$, $6'+1/4''$, $6'+1/8''$, ... (and its reflection: $6'-1/2''$, $6'-1/4''$, $6'-1/8''$, ...) If a coarse-grained similarity metric is in play, then there will be a point, say $6'+1/1024''$,

below which the difference is too minor to constitute any difference in similarity. In this case there will be a sphere of nearest $\sim p$-worlds from $6'+1/1024''$ on in. Either way, L must include some infinite subsequence of the sequence of $\sim p$-worlds: $6'+1/2''$, $6'+1/4''$, $6'+1/8''$, ... (such as $6'+1/1024''$, $6'+1/2048''$, $6'+1/4096''$, ...). The upshot is that, in order to meet condition (3), it must be the case that, throughout this infinite subsequence of the sequence of $\sim p$-worlds, Percy believes that Sextus is precisely $6'$ at w iff Sextus is precisely $6'$ at w.

Now Percy is wrecked. His perceptual margin for error will falsify condition (3). For any $\sim p$-world $w1$ at which Percy would stay on track by believing that $\sim p$, there exists an at-least-equally-near $\sim p$-world $w2$ at which Percy derails, by still believing that p. For example, suppose that Percy can only notice differences of $1/4''$ or greater. Then the nearest $\sim p$ worlds at which he would believe that $\sim p$ would be $6'\pm 1/4''$ worlds. And then there is an-at-least-equally-near $6'+1/8''$ $\sim p$-world at which he would still believe that p, for lack of a noticeable difference. And so the sphere of nearby possibilities contains an inner hollow through which Percy's perceptual knowledge derails: he believes that p, but p is false. In a nutshell, the problem is that the tracking theory is requiring that Percy discriminate between the case of Sextus being $6'$ and the case of Sextus being $6'+1/4096''$, which is just not humanly possible.

Now the tracking theorist should not (yet) be troubled by this result. Given the extreme rendering of p as precise, knowledge that p *should* count as beyond human perceptual competence – surely Percy does *not* know that Sextus is *precisely* $6'$ tall! The tracking theorist should maintain that (i) all Percy should ever count as knowing is that Sextus is *roughly* $6'$ tall, and (ii) some more reasonable rendering of p as vague will pull perceptual knowledge back on track. What would be troubling for the tracking theorist would be if (ii) were false. And this is what I maintain: the vagueness sifts all the way through, the inner hollow stays, the derailing remains.

4. INNER DERAILING, PART II: VAGUE BELIEF

No doubt Percy's belief that p is not perfectly precise. It should not be identified with all and only those worlds in which Sextus

is exactly 6′ tall, but rather with some vague extension: those worlds in which Sextus is *roughly* 6′ tall. Unfortunately (i) there is little agreement as to how to model vague content, (ii) certain accounts of vagueness complicate the notion of truth in such a way that the tracking theory itself (which speaks of covariation of belief with truth) requires reformulation, and (iii) tracking theorists have yet to offer guidance here.

I propose to consider each of the four leading conceptions of vagueness. These are: (1) *degree theories*, on which vagueness is degree of truth, (2) *supervaluation theories*, on which vagueness is semantic indecision, (3) *epistemic theories*, on which vagueness is ignorance, and (4) *ontological theories*, on which vagueness is 'in the world'. I argue that, at least on the most natural way to integrate each conception into the tracking theory, the problem of inner derailing remains. While I cannot rule out that there is some other, yet-to-be specified way of understanding vagueness and integrating it into the tracking theory that would avoid inner derailing, I suggest that this is very unlikely.

Starting with degree theories, on such theories "Percy believes that Sextus is six-feet tall" will be true to degree j, and "Sextus is six-feet tall" will be true to degree k. The most natural reformulation of the tracking theory modifies the original condition (3) to (3′): for every possibility w in L, "s believes that p" is true to degree x at w iff "p" is true to degree x at w. On this reformulation, knowledge is counterfactual covariation of degree-of-belief with degree-of-truth.[6]

The derailing remains. Suppose that "Percy believes that Sextus is six-feet tall" is true to degree j and "Sextus is six-feet tall" is also true to degree j. Consider any Δp-world $w1$ at which (i) "Sextus is six-feet tall" is true to a lesser degree k ($k < j$), and (ii) "Percy believes that Sextus is six-feet tall" is also true to degree k. Because of Percy's margin for error, there will exist an at least equally near Δp-world $w2$ at which (i) "Sextus is six-feet tall" is true to some intermediate degree l ($k < l < j$), but (ii) "Percy believes that Sextus is six-feet tall" remains at degree j for lack of a noticeable difference. Slight changes of degree cannot be tracked.

Turning to supervaluation theories, such theories employ the notion of an admissible *precisification*, which is a semantic decision as to how precisely to set boundaries, compatible with the meaning

postulates in play. Truth is then relativized to a precisification. Unrelativized truth gives way to *supertruth*, where p is supertrue iff p is true in every admissible precisification; unrelativized falsity gives way to *superfalsity*, where p is superfalse iff p is false in every admissible precisification. (Degrees of truth can then, if wanted, be defined in terms of the ratio of admissible precisifications in which p is true to total admissible precisifications, at least in the finite case.)

The most natural reformulation of the tracking theory would be in terms of *supertracking*. The best way to think of this is to pretend that 'Percy believes that ...' is precise for the moment, and to consider the various admissible precisifications of p. The original condition (3) should then turn out supertrue. That is, it should then be supertrue that: Percy believes that p iff p.

Yet it turns out super*false* that Percy believes that p iff p. Each admissible precisification may be thought of as setting a sharp margin ε, such that the p-worlds are all and only those worlds in which Sextus is $6'\pm\varepsilon$ (including the limiting case of $\varepsilon = 0$, which generates the extreme interpretation discussed in §3). Now the same inner derailing problem arises on every admissible precisification. For each such precisification, the infinite sequence of ever nearer $\sim p$-worlds just moves to: $6'+\varepsilon+1/2''$, $6'+\varepsilon+1/4''$, $6'+\varepsilon+1/8''$, ... There will be some infinite subsequence of this sequence, say $6'+\varepsilon+1/8''$ down, which Percy cannot discriminate from $6'+\varepsilon$, due to perceptual error. Any semantic decision will set a line that Percy cannot track.

Moving on to epistemic theories, such theories identify the content of p with some precise interval $6'\pm n$, where the value of n is cognitively inaccessible. On this rendering the p-worlds are all and only those worlds in which Sextus is exactly $6'\pm n$, for some hidden borderline n. Now there will be some infinite subsequence of: $6'+n+1/2''$, $6'+n+1/4''$, $6'+n+1/8''$, ..., say $6'+n+1/8''$ down, which s cannot discriminate from $6'+n$. Indeed the epistemicist's explanation for our ignorance with regard to the value of n just is our inability to perceptually discriminate $6'+n$ from $6'+n+1/2056''$ (Williamson, 1994, ch. 8). Epistemicism posits the very ignorance that derails Percy.

Turning finally to ontological theories, on such theories vagueness is 'in the world', so that Percy's height is no exact height, but is

itself roughly $6'$. I doubt this is coherent, but in any case it will not help prevent derailing. The reason is that, to whatever degree a fact is actually 'vague', it will still be less vague than Percy's margin for error (– whatever vagueness may be 'in the world' is not perfectly calibrated to our perceptual capacities). A more accurate measuring device than Percy's eyes can pin Sextus's height to within a narrower margin. In fact the very possibility of psychophysical determinations of j.n.d.s (§2) *presupposes* that there are measuring devices that can pin the quality of the stimulus to a narrower range than can unaided perception. That's how we can tell that human subjects make errors. Ontological vagueness still posits a world precise enough to derail Percy.

So it does not appear that vagueness prevents derailing. In hindsight this is perhaps unsurprising. The kind of inner derailing at issue arises because of perceptual insensitivity. Human perceivers cannot distinguish adjacent cases. But all theories of vagueness do distinguish adjacent cases (whether as true to different degrees, or true under different precisifications, or as potentially crossing the hidden line). They must if they are to reject the Sorites premise. What emerges is that, however it is that a theory of vagueness distinguishes adjacent cases, this generates an associated failure of tracking. So it seems unlikely that the integration of vagueness into the tracking theory will pull perception back on track. I think this should be deeply troubling for the tracking theorist.

5. INNER DERAILING, PART III: INTERVAL BELIEF

The tracking theorist might try the following maneuver to pull perception back on track in the inner hollow of indiscriminable differences. She might grant that Percy does not know that Sextus is *precisely* $6'$ tall, take no stand on whether Percy knows that Sextus is *roughly* $6'$ tall, and instead maintain that Percy still knows such things as that Sextus is *between* $5'$ and $7'$ tall. Suppose Percy's margin of error is $\pm 1''$. Then, intuitively, we should want Percy to count as not knowing that Sextus is precisely $6'$, or in the precise interval $[6'-1/2'', 6'+1/2'']$, or in $[6'-1/4'', 6'+1/4'']$. And we should want Percy to count as knowing that Sextus is in the precise interval $[5'11'', 6'1'']$, or in $[5'10'', 6'2'']$, or $[5'9'', 6'3'']$. In general, if Percy's

margin or error is $\pm n$, we should want him to count as knowing that Sextus is in the precise interval $[6'-h, 6'+h]$ iff $n \leq h$.[7]

This maneuver invites two questions. First, does the tracking theory at least allow for Percy to have knowledge for wide enough interval beliefs, such as that Sextus is between $5'$ and $7'$? And second, if so, would this help the tracking theorist with perceptual knowledge? I maintain that the answer to each question is: *no*.

Does the tracking theory at least allow for Percy to have knowledge for wide enough interval beliefs, such as that Sextus is between $5'$ and $7'$? Applying condition (3) of the tracking theory (§1), what is required is that Percy can track whether Sextus is in the precise interval $[5', 7']$. And this requires that the tracking sphere L extend out to at least one nearby $\sim p$-world. And this requirement cannot be met, because it requires Percy to track the truth across the border of the interval. The result here is exactly parallel to the result for epistemic theories of vagueness (§4), with n (the hidden borderline) set to the radius of the interval. The underlying problem is that Percy is still being required to discriminate between (i) cases barely inside the border such as where Sextus is precisely $7'$, and (ii) cases barely outside the border such as where Sextus is $7'+1/4096''$. This requirement is not humanly attainable.

Even if the tracking theory did allow Percy to have knowledge for beliefs about intervals (of sufficient width), would this help with perceptual knowledge? – *Only if the paradigmatic cases of perceptual knowledge involve beliefs about intervals*. And here it only needs to be pointed out that (i) Percy's belief that p: Sextus is $6'$ tall, is a paradigmatic case of perceptual knowledge, and (ii) it is not linguistically plausible to interpret p as a belief about an interval. What is plausible is to interpret p as having vague content (§4) – vague belief is the right way for the tracking theorist to turn. So even if the tracking theory did succeed for interval beliefs, such would be beside the point.

What emerges is a second version of the inner derailing problem for the tracking theory. Intuitively, Percy knows *both* (i) that Sextus is $6'$ tall, and (ii) that Sextus is between $5'$ and $7'$ tall. But the tracking theory cannot respect *either* (i) *or* (ii). I conclude that the tracking theory, or at least any theory that requires counterfactual covariation of belief and truth through a sphere of possibilities

extending from actuality out to at least one $\sim p$-world, imposes requirements that are completely out of line with human perceptual competence.[8]

6. OUTER DERAILING

Suppose that Percy the perceiver sees Hans the handed, and forms the true belief that q: Hans does not have mile long tentacles. Does Percy know that q? Obviously so, I say; or at least obviously so under the right assumptions and conditions (§3), which I shall assume to be in place.

Does the tracking theory respect the verdict that Percy knows that q? Since Percy has a true belief by hypothesis, conditions (1) and (2) of the tracking theory (§1) are met. So it remains to test condition (3): Is it the case that, for every possibility w in the actuality-centered sphere of worlds L, Percy believes that q at w iff q is true at w?

Here I continue to assume that L must radiate out to at least one $\sim q$-world (§1). So L must radiate out to at least one world in which Hans has mile long tentacles.

Now Percy is wrecked. There are two reasons for this, one old and one new. The old reason is that there will be worlds in L in which Hans has tentacles that are 1 m–1/2″ long, 1 m–1/4″ long, 1 m–1/8″ long, . . .

The new reason is that L must now radiate out so far into logical space that it will include skeptical scenarios. By any reasonable measure of similarity, there are worlds in which Percy is dreaming of mile long tentacles, or enjoying an LSD-induced hallucination of mile long tentacles, that are nearer to actuality than worlds in which Hans has mile long tentacles. Dreaming is an everynight affair. LSD hallucinations actually happen. The possession of mile long tentacles is in a different league.[9]

In general, there are many, many scenarios that are (i) clearly more distant than certain skeptical scenarios, but for which (ii) human perception is adequate. The tracking theory cannot accommodate our perceptual knowledge that any of these scenarios fail to obtain.[10]

7. CONCLUSION

Human perceptual competence forms a discontinuous scatter in logical space. Every world at which one has a true perceptual belief is surrounded by an inner hollow of nearby worlds at which one derails: there is an inner hollow of perceptual incompetence. And one's true perceptual beliefs about the failure of sufficiently far-flung scenarios to obtain extend past skeptical sinkholes: there are outlying islands of perceptual competence.

The tracking theory identifies knowledge with counterfactual covariation of belief and truth through a sphere of possibilities. The contents of the sphere are determined by the similarity metric. Derailings occur because the similarity metric (on any reasonable interpretation) is completely out of alignment with our actual rough-and-ready perceptual capacities. The problem is systematic: the mismatch between the smoothness of logical space and the roughness of human perception is not likely to be fixed by a further epicycle.

The derailing problem generalizes in two ways, which I shall note by way of conclusion. First, the derailing problem generalizes beyond perceivers to thermometers and other decent-but-imperfect indicators of the external world. Thermometers fail to track inner pockets of temperature shifts, since the atmospheric pressure is never completely fixed, the mercury is never perfectly homogeneous, the tube is never perfectly regular, etc. And thermometers succeed in indicating that the temperature is not a trillion trillion degrees hereabouts, even though thermometer-malfunction possibilities may be far closer to actuality than possibilities in which it reaches a trillion trillion degrees hereabouts. While it is in some sense intuitively apt to speak of a thermometer as 'tracking' the temperature (and likewise intuitively apt to speak of a perceiver as 'tracking' the environment), the tracking theory (§1) does not respect this verdict. So in whatever sense it is apt to speak of thermometers and perceivers as 'trackers', this sense cannot be analyzed in terms of counterfactual covariation through a sphere of possibilities. There is some irony here in that the tracking theory is generally regarded as an implementation of the thermometer model of knowledge (Armstrong, 1973).

Second, the derailing problem generalizes beyond perceptual knowledge to memorial and testimonial knowledge. Memorial and testimonial knowledge survive as records of perceptual knowledge, and inherit the limitations of perception thereby. Further, memory and testimony introduce further epistemic imperfections as the memory trace blurs and as noise enters the testimonial message. Thus the tracking theory misrepresents our memorial and testimonial competencies as well.

NOTES

[1] The formulation of the main text is intended to preserve the truth + belief + x format, but it pays the price of redundancy. Given the tracking condition (3) and given that actuality is in L, the truth and belief conditions (1) and (2) are equivalent. The formulation of the main text also omits a temporal index t.

[2] Nozick's actual formulation of the tracking account somewhat obscures this fact. Nozick's formulation is: s knows that p iff (1) p is true, (2) s believes that p, (3) $p > s$ believes that p, (4) $\sim p > s$ believes that $\sim p$. On the Stalnaker-Lewis semantics for counterfactuals, Nozick's (3) follows trivially from his (1) and (2). So it might seem that Nozick does not require tracking through a sphere, but only (i) actual coextension of truth and belief, and (ii) counterfactual coextension of truth and belief at the nearest $\sim p$ world. Not so: Nozick means by (3), and needs to mean by (3), that truth and belief coextend through the neighborhood of worlds out to the nearest $\sim p$ world in (4) (see Nozick's, p. 176 and esp. note 8, pp. 680–681).

[3] Exception: if particle P is traveling at just below the speed of light, and if $w1$ differs from actuality in that P speeds up slightly but enough to exceed the speed of light, while $w2$ differs from actuality in that P slows down dramatically, then $w2$ is nearer to actuality than $w1$ is. Here there are deep nomological reasons why certain r-wise differences are special.

[4] Idealization: Assuming we implement counterfactual changes by introducing "miracles", differences in miracle will ramify through, and create a cascade of subsequent differences. For instance, if we introduce a Sextus-growth miracle, we should have him grow gradually: his scalp should not accelerate at superluminal velocities. But now it will take a bit longer to have Sextus grow $1/32''$ than to grow $1/64''$. Facts about the distribution of mass through the universe will thereby differ, though perhaps not in any determinate way. So the idea of two worlds differing from actuality in respect r only is highly idealized. But the cascade of subsequent differences is typically something we ignore in counterfactual reasoning, as too complex and too indeterminate to calculate. So the resulting idealization is unavoidable.

[5] Unless there are deep biological reasons why a height difference of, say, $1/4''$ is actually easier to generate than any smaller difference. Since the example is

supposed to be representative, nothing essential turns on this assumption. One could just as easily use an example concerning a continuum of differences in any perceptual property: the length of a segment, the color of a swatch, the volume of a note, etc.

[6] If one thinks of the degree-theoretic biconditional as being true to degree 1 just in case both bijuncts are true to the same degree, then this natural reformulation follows from the thought that the originally formulated condition(3) should hold to degree 1.

[7] Thanks to Stewart Cohen for this suggestion.

[8] The problem of inner derailing shows that subjects make perceptual errors at nearby worlds. The problem thus generalizes to any theory that requires otherwise, including the theory of Ernest Sosa (1999), which requires *safety*: *s* believes that *p* (where this counterfactual is stipulated to extend beyond the actual world into the neighborhood of nearby *p*-worlds). Perceivers are not safe with truth, and can *very* easily go wrong, when the differences are small.

[9] If one has any doubts about this one is invited to consider thousand mile long tentacles, wriggling faster than the speed of light, and composed of unobtainium. It is true that the similarity metric has some aspect of context-sensitivity, but not *that* much.

[10] As Stewart Cohen has helped me to see, the problem of outer derailing arises because the tracking theorist (§1) invokes a single tracking sphere. A modified theory that allowed for multiple tracking-bands might avoid this problem if, for instance, it only required that *s* track truth (i) at a band around actuality, and (ii) at a band around the nearest $\sim p$-world. The skeptical sinkholes that lead to outer derailing would then be exiled to the median between these bands. While a full consideration of the prospects for such a theory is well beyond the scope of this paper, I should note three complications: (i) this theory would still face the problem of inner derailing, (ii) this theory would complicate life for contextualists who would now have to invoke multiple rules to ply multiple bands, and (iii) this theory would no longer underwrite, e.g., Nozick's solution to the Gettier problem, which requires the invocation of possibilities from the median.

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