Philosophy of Science—Nineteenth-Century Developments

NATURALISTIC METHODOLOGY IN AN EMERGING SCIENTIFIC PSYCHOLOGY: LOTZE AND FECHNER IN THE BALANCE

by Patrick McDonald

Abstract. The development of a methodologically naturalistic approach to physiological and experimental psychology in the nineteenth century was not primarily driven by a naturalistic agenda. The work of R. Hermann Lotze and G. T. Fechner help to illustrate this claim. I examine a selected set of central commitments in each thinker's philosophical outlook, particularly regarding the human soul and the nature of God, that departed strongly from a reductionist materialism. Yet, each contributed significantly to the formation of experimental and physiological psychology. Their work was influenced substantively by their respective philosophical commitments. Nevertheless, the evaluation of the merits of their specific proposals, Fechner's psychophysics and Lotze's local sign hypothesis respectively, did not depend upon sharing their metaphysical views regarding the human soul or the nature of God. A moderate, but significant, distinction between the contexts of discovery and of justification aids in understanding this balancing act.

Keywords: G. T. Fechner; local signs; R. Hermann Lotze; Ernst Mach; methodological naturalism; neo-Kantianism; physiological psychology; psychophysics; spatial perception

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The fields of physiological and experimental psychology underwent a dramatic stage of development in the middle of the nineteenth century. Two important contributors to the methodological vision and content of the new psychology were the German philosopher/scientists Rudolf Hermann Lotze (1817–1881) and Gustav Theodor Fechner (1801–1887). Each developed naturalistic methods in psychology while articulating incisively critical responses to materialistic metaphysical pictures. They balanced two interests: recognition of the emerging robustness of empirical investigations into the mind (here a leaning toward forms of methodological naturalism) and their commitment that the human soul and value structures cannot be wholly explained in terms of the physical (or physiological). Each thinker addressed the problem, in part, by distinguishing the proper scope of science from that of philosophy and theology.

Lotze and Fechner considered physiological psychology and/or psychophysics to involve the connection of physical and psychological phenomena according to precise and exact laws. In defending empirical methods they contributed to the developing consensus in the nineteenth century regarding the importance of methodological naturalism within science. By methodological naturalism I mean that science aims to understand the natural world (including the human part of the natural world) by empirical methods, without postulating for the purposes of adjudication, supernatural processes and events, and without appeal to explicit theological or religious assumptions.[1] Some critics worry that methodological naturalism follows from or leads to an implicit metaphysically naturalistic worldview—that nature is all there is. Among other critics, philosopher Alvin Plantinga (1991; 1996) has questioned the reasons for holding methodological naturalism to be an essential characteristic of good science. He has proposed that in some cases it would be acceptable to make use of theistic assumptions in the evaluation of scientific theories (evolutionary theory, naturalistic theories of altruism, and the like). Others have proposed ways in which theological assumptions can play an explicit role in scientific discussions, opening the door to design theoretic explanations.[2]

One way to respond is to show that methodological naturalism has emerged as a de facto if not de jure operating assumption in science for good reasons (as outlined in Numbers 2003). Further, it seems, the many methodological decisions and discussions that have resulted in a fairly universal commitment to methodological naturalism in science have not been dominated by metaphysically naturalistic agendas. Lotze and Fechner provide a model of helpful dialogue in which naturalistic methods in psychology are placed in a larger philosophical framework that was not naturalistic in the sense that concerns many contemporary theists. Lotze even attempted to carve out a place in which metaphysical and ethical concerns can play a substantive role in the evaluation of scientific hypotheses. In Lotze's case, this evaluation largely comes in the discipline of philosophical investiga-

tion, though it found traction in the practice of psychology as a science. Fechner's view of the human mind and the human person allows for somewhat less of a role for such concerns in the practice of hypothesis evaluation. In what follows, I explore briefly how Lotze and Fechner carried out the dialogue between their respective philosophical commitments and scientific proposals in sensory psychology.

Two specific cases provide the focal points: Fechner's psychophysics, specifically his proposal for a science of the measurement of sensations, and Lotze's hypothesis of local signs to explain spatial localization in human perception. In each, empirical methods played a significant role; however, the hypotheses emerged in part on the basis of philosophical commitments about the mind-body relation and a broader metaphysic concerning the nature of God and the cosmos that informs the place of the human in the world. The metaphysics motivated the investigations and, in part, the defense against criticisms. However, each thinker formulated his particular hypotheses in such a way that they could be clearly tested, evaluated, and criticized independently of his deeper philosophical commitments regarding the soul.

Fechner's psychophysics assumes that the mental is precisely measurable, at least in an indirect way. His proposal met with a significant range of critique, much of it quite technical in nature, and some of it predicated upon differences in epistemological commitments. In response, Fechner sought out a way to balance his defense of psychophysics between idiosyncratic philosophical commitments and more generally accepted empirical and conceptual arguments. Similarly, Lotze's articulation of the theory of local signs may have a tight conceptual connection to his immaterialist picture of the human soul. In his view, conscious experiences that are the reality of "spatial perception and localization" are functions of the soul. Given an immaterial picture of the soul, the contents are not possibly spatially extended; thus was needed some qualitative content to account for the soul's ability to localize sensations in a subjective spatial framework. Local signs were postulated to do that work. However, Lotze's (and others') continued defense of the hypothesis appealed to its explanatory power as a way to account for spatial localization.

In this essay I attempt to balance a number of distinct interests. First, I show that metaphysical and at least nominally religious commitments played a nontrivial role in the emergence of a mature experimental psychology in the latter half of the nineteenth century. As Gary Hatfield has argued in a number of places (1990; 1997; 2002), the new psychology did not simply emerge by performing a surgical removal of philosophical concerns (especially metaphysical). However, as the study of sensory psychology became increasingly tied to physiology and experiment in the latter half of the nineteenth century, it became increasingly autonomous from traditional religious and philosophical conceptions of the soul. As work became more

and more specialized and methods standardized, the physiological psychology of the senses became largely autonomous from philosophy of mind and from the theology of the person. Although in many ways a difficult story to tell as a clean emergence of disciplinary autonomy (Dixon 1999; Hatfield 1997), I consider it safe to say that the naturalization of sensory psychology is a chapter in the history of a methodologically naturalistic (near) consensus.

However, it is important to understand that the move toward more naturalistic methods was not primarily motivated by a prior commitment to any particular worldview, whether theistic, naturalistic, pantheistic, or other. Rather, as questions became more precise in both physiology and psychology, it made sense to articulate ways to make such questions clearly adjudicable. The fact that clear antireductionists such as Lotze and Fechner helped significantly to develop the tools of naturalization sheds light on the epistemic status of such naturalistic methodologies. Put simply, they formulated hypotheses that were consistent with distinct worldviews and as such could be tested empirically in a context of methodologically naturalistic (that is, experimental) psychology.[3]

Methodological Naturalism and Worldview Independence

I argue, simply, that worries about metaphysical naturalism being established by a Trojan horse of methodological naturalism (MN) are not well founded. The cases of Lotze and Fechner clearly are insufficient by themselves to establish this. However, their work helps to show that, with respect to belief in God and specific faith traditions (for example, Christianity, the tradition out of which these two thought and worked), as a guide for the evaluation of scientific hypotheses, MN is neutral with respect to deeper worldview commitments.

There is no need to consider MN to be part of the essence or definition of science in any strong sense.[4] However, I would like to find an articulation of MN that can function as a strong, even if fallible, norm in contemporary scientific practice. Also, I emphasize that MN applies primarily within the context of justification, broadly considered. I will not defend a picture of the two contexts as hermetically sealed. In fact, part of the interest of Lotze and Fechner is that their concrete contributions to the development of experimental psychology, and specifically certain key elements of their concrete hypotheses, seem to have been motivated precisely by what we would call deeply metaphysical—and thus worldview—commitments. However, they were clear that there is a distinction to be made about aspects of scientific practice that fall into one or the other. That is, the distinction need not be sharp in all cases in order to be sharp in some and for that sharp distinction to matter.

In the context of testing and evaluating a hypothesis (that of justification), there is a stronger view of worldview independence and a more moderate view. The stronger might look this way:

- *Strong Independence:* A hypothesis, law, or theory can be distinguished from background philosophical or religious assumptions with no loss of sense or content. Thus, one may test the hypothesis without sharing a background worldview.

I formulate the strong version because it may seem at first glance to be what the MN view needs to isolate the supernatural from science. However, it is probably too strong. It seems plausible that many hypotheses do lose some of their sense when transported from one context to another.[5] Yet, maybe a weaker version will suffice:

- *Moderate Independence:* A hypothesis, law, or theory can be distinguished from background philosophical or religious assumptions with no epistemically critical loss of sense or content.

The main support for this would be the many cases in the history of science in which critics of a hypothesis who did not share "relevant" background philosophical commitments still engaged hypotheses, understood their central meaning, and in some sense successfully evaluated their merits in light of experiments or observations. This can happen even if, strictly speaking, the hypothesis is not exactly the same (that is, shares completely in meaning structure) as the one originally proposed. The background beliefs may still play a meaningful role in the process, while the community at large may insist upon their exclusion in central justificatory contexts. The warrant for such exclusion would be the record of keeping such higher-level commitments out of play when attempting to evaluate the merits of a hypothesis. This in no way constrains theory evaluation to narrowly empirical grounds; however, it does practically isolate many controversial philosophical, and especially metaphysical, propositions from the so-called context of justification in science. I show next how this has worked with Fechner's hypothesis of psychophysical measurement and Lotze's local sign theory.[6]

Fechner's Psychophysics and the Philosophy of the Day View

Fechner developed a comprehensive philosophical picture, the Day View (*Tagesansicht*, as opposed to the *Nachtansicht*, or Night View), that included an epistemology, an ontology, a theory of value, an aesthetic picture, and a view of the religious life. I do not rehearse all of this here for a number of reasons, a primary one being that Michael Heidelberger in his book *Nature from Within* (2004) has provided a very complete and helpful discussion of the basic tenets of the Day View. Yet, it will help to dwell briefly on a few

central elements of his view of the human person and its wider philosophical and theological implications. He incorporated key features of Friedrich Schelling's *Naturphilosophie* and its dual-aspect identity theory of Nature, God, and the human person. In Fechner's version, the totality of nature looked at from an empirical/physical (broadly speaking) standpoint is one side of God, and the inner side constitutes God's own mental life, agency, and personhood. The human person has a physical side, wholly integrated into the natural order, and an inner mental side. Neither side is reducible to the other; thus, Heidelberger calls the view psychophysical parallelism.[7] The view does seem to lead to a form of pantheism, which Fechner embraced. If all embodied beings are two-sided unities, one side completely part of the order of physical law and the other side part of the universe of the mental or soulful, it follows that we are all simply proper parts of the divine order. Fechner's view avoids reducing all to the ideal or spiritual just as much as he avoids a reductive physicalistic picture (what seems to be what he often has in mind by the *Nachtansicht*, Night View—yet, either extreme could qualify as a species of a *Nachtansicht*).[8]

Fechner suffered a significant personal crisis lasting from late 1839 to around the spring of 1843. His emergence from the crisis left him with a sense of renewal that appeared to be a kind of religious conversion. He first articulates the Day View in a mature way in his 1851 *Zend-Avesta*.[9] The 1855 *Atomenlehre* (Atomic Theory) develops his philosophy of science in light of the Day View. He compiles his thoughts in a more compact way in the 1879 *Die Tagesansicht gegenueber der Nachtansicht* (The Day View Opposed to the Night View).

The central claims of the Day View may be summarized as follows. First, Fechner adopts a directly realist view of perception—that is, he denies that the qualities of perceptions are mere representations of the objects perceived (or, worse, the only objects perceived, merely being the end of a causal chain that might lead back to the "objects" in the world). He denies any basic distinction between secondary and primary qualities. He denies that we interact with a world of extended space with a network of "colorless, dead" atoms that, when interacting in the human perceiver, induce a range of perceived attributes from colors and smells to extended objects and motion in the perceptual space. The mind experiences phenomena, and the phenomena just are the things experienced. Thus, he also rejects any Kantian notion of a *Ding an sich* (thing in itself). Second, everything that exists participates in a dual-aspect monistic reality. Humans have an outer, bodily, side and an inner, spiritual or mental, side. God is the inner psychological side of the entire material, natural order. A corollary to this is that human consciousness is only a part of or a moment in God's consciousness. Finally, because the human body and mind are parallel tracks of one entity, the two sides closely track each other. Fechner describes a few of the central tenets of the Day View in the following way:

> [T]he *punctum saliens* we might call it, of the development of the Daylight View of the world is the mediating point between above and below at which we recognize that the contrast in which we stand to God is not an outward one, like that of a part to a part, or one step of a stair to another, but an inward one, like that of a part to the whole, or that of a step to the flight of steps. For from this view-point God's nature is no longer entirely inconceivable to us; we are ourselves a breath emanating from the divine Being, a tiny particle, a little step or sample. Not only the fact of God's existence, but some notion of the inward relationships in the divine nature is, as seen from this view-point, immediately accessible to us as mirrored or exemplified in the inward relationships we find in ourselves; and from this starting-point broadened and exalted points of view are available—not indeed to know God exhaustively, but in order that by the knowledge of the mode of His being and of His relation to us we may advance further and climb higher—points of view which encourage generalization, justify analogy, and take account of likeness, contrast, and gradation. (Fechner 1879, 247)

He goes on to discuss briefly how we can expect to live on after death because our existence is already a part of God's existence and will continue to be so, one way or another.

How did Fechner integrate his philosophical theology into his psychophysical investigations? He embedded his psychophysical project within the panpsychist *Naturphilosophie* and pantheistic theology of the Day View, as seen in, for example, the *Zend-Avesta*. There the whole framework is presented in one package. Indeed, Fechner tells us that the view articulated at great length in the *Zend-Avesta* and published in 1851 had a significant influence on his work through the 1850s in carrying out the empirical investigations that constituted much of his 1860 publication establishing the study of psychophysics; his philosophical framework provided, in his view, a unifying conceptual picture to psychophysics. However, Fechner also argued—and I think there are good reasons to take him at his word—that psychophysics has an empirical foundation (it is of course not simply an empirical enterprise in a narrow sense of that term) and should be adjudicated as to its merits/demerits on broadly empirical grounds. As he suggests in his preface to the *Elements of Psychophysics* (Fechner [1860] 1966), one need not accept the whole vision in order to assess psychophysics; it should stand or fall on its merits as an empirical research program (not his words, of course) that illuminates the detailed and precise functional relations of mind and body. He thought it illuminated the philosophical issue of the mind-body problem, that it fit nicely within a broader conception of the human person and the religious life. He also held that philosophers and theologians should work with psychologists and physiologists to articulate a unified picture. However, success or failure in this latter task should not fundamentally affect the evaluation of the scientific status of psychophysics. In the next section, Fechner's discussion of measuring sensation helps to illustrate this point.

The text of the *Elements* provides some guidance. Fechner states that his investigations were undertaken to transform discussion of the mind-body

relation into a more exact science. He argues that the relation of mind and matter had to that point remained a field for philosophical debates "without solid foundation and without sure principles and methods for the progress of inquiry" ([1860] 1966, 1). Introducing his two-volume *Elements*, he provides a *precis* of his nonreductive identity view of the mind and body while contrasting it with some of the alternatives (Cartesian dualism, dualist occasionalism, dualist preestablished harmony, parallelism). Because we have a privileged internal standpoint, we appear to ourselves as self-identical, and others see only our external side. However, that natural science relies upon the external standpoint and is successful is no reason to dispense with the internal standpoint. It matters not whether one considers body and mind as two different modes of appearance of the same entity or as two entities connected somehow externally to each other, or whether one gives up on any unified approach, adopting a philosophical agnosticism about the mind-body relation.

> Insofar as an empirical relationship between body and mind is acknowledged and its empirical pursuit allowed, there is no objection to trying even the most complicated kind of representation. In what follows we shall base our inquiry only on the empirical relationships of body and mind, and in addition adopt for use the most common expressions for the designation of these facts, though they are expressed more in terms of a dualistic approach than my own monistic one. Translation from one to the other is easy. ([1860] 1966, 5)

Furthermore, although the theory of the psychophysical relation he has developed will not "be altogether indifferent to the points of view on the basic relationships of body and mind and without influence upon them, for the contrary is true," he emphasizes quite clearly that the basis of the theory is "indeed purely empirical, and every assumption is to be rejected from the start" (p. 5). I take "assumption" here to mean nonempirical assumptions that are contested among distinct philosophical schools. Of course, exactly what sorts of experiences or experimental investigations form the basis of the psychophysical investigations became a matter of dispute. The immediate relationship of body and mind is beyond direct experiential access. That is part of the problem that psychophysics aimed to address.

Fechner holds that the acceptability and de facto acceptance itself of his Day View is not particularly relevant to the case for his psychophysical investigations and, in particular, his psychophysical law.

> The proof, the fertility, and the depth of a universal law do not depend on the general principles but on the elementary facts. The law of gravitation and the molecular laws . . . are elementary laws; were they thoroughly known and the whole range of their implications exhausted, we would have a theory of the material world in its most general form. Similarly we must seek to form elementary laws of the relationship of the material and the mental world in order to gain a durable and developed theory instead of a general opinion, and we will only be

able to do this, here as elsewhere, by building on a foundation of elementary facts. Psychophysics is a theory that must be based on this point of view. (p. 6)

There is no doubt that the philosophical formation of the Day View played a significant role in Fechner's path to psychophysics. This fact may support the conclusion that the philosophical and religious dimensions of this formation were crucial to the path of discovery. Thus, philosophical and theological inquiry may play a proper part in the context of education, discussion, and inquiry of at least certain forms of scientific endeavor. However, is it the case that the evaluation of the merits of psychophysics depends upon broader philosophical and or theological considerations? We will look at a few examples of criticisms.

In Defense of Psychophysical Measurement

Fechner introduced the germ of the idea of pyschophysics in the *Zend-Avesta* of 1851. He spent much of the decade of the 1850s carrying out experiments and gathering other data to develop the model of lawful correlations of stimuli and sensory magnitude in detail. After the publication in 1860 of *Elements of Psychophysics* there was a reasonably positive reception among physiological psychologists and some constructive engagement. It was in the middle of the 1870s that significant criticisms began to emerge. Philosophical assumptions played a part in the substance of the major criticisms. For example, there were a number of neo-Kantian critics, including Hermann Cohen and Freiburg physiologist Johannes von Kries. Neo-Kantian objections seem to have revolved in part around the claim that no objective science can be based in any significant way upon "sensations," for these are merely subjective and thus cannot be properly scientific. To be scientific a field must be based on the directly measurable in terms of extensive magnitudes subject to (Kant's) *pure* intuitions of space and time. Because sensations presumably did not meet the criteria, psychophysics, as conceived by Fechner, was unscientific. It might make for interesting philosophy, but not for science (Heidelberger [1993] 2004, 217–29).

In his articulation of the central claims and vision of psychophysics, Fechner built upon the work of Ernst Heinrich Weber, his Leipzig colleague, who had investigated sensations of touch and the discrimination of differences in weights in the 1840s. Fechner attributes to Weber the establishment of the following fundamental relationship between the change of sensation and the change of stimulus:

$$E = (\ R/R)\ k \qquad (1)$$

where E is the intensity of the sensation and R is the intensity of the stimulus. For example, if R (*Reiz*—stimulus) is a light source, E (*Empfindung*—sensation) would be the sensation of light induced by the physical light. By defining E and R as infinitesimals he set up the following:

$$dE = (dR/R)\, k \qquad (2)$$

Fechner developed this relationship into his own law of psychophysics, by integrating each side of (2):

$$E = k\,(\log R) + C \qquad (3)$$

As Heidelberger has worked out in detail, the Day View played an important role in Fechner's thinking through the problem of measuring sensations and correlating them with stimulus intensities. Psychophysics is based on an assumption that one can determine a precise way to measure sensations.

By the mid-1870s, criticisms of Fechner's psychophysics began to appear, ranging over a number of basic issues. Most important for this essay, there were a number of critics who questioned whether sensations in particular and psychological magnitudes in general are measurable (Heidelberger [1993] 2004). The problem of the measurability of sensations cut to the heart of the viability of the psychophysical project as a scientific research program. In his anonymous review of Fechner's *Elements*, Jules Tannery levied a number of basic criticisms of the measurability thesis assumed by psychophysics. He argued that additivity and equality make no sense in the realm of sensations. There exists no clear definition for the sum or difference of two sensations. The only dimensions measurable are those for which one can define equality and summation. So, sensations are not measurable. He added a second criticism similar to the first. Fechner's response to the critics may reflect certain assumptions of the Day View (Heidelberger [1993] 2004, 208–10). However, I will suggest why it is possible to defend psychophysics as a moderately independent hypothesis about the measurability of sensations.

Many of the critics of the project took their point of departure from a neo-Kantian view of the objectivity of science. Here the main feature of scientific objectivity, in addition to conforming to a causal law, was having quantities available to such laws that were measurable in terms of space, time, and mass. The basic substance of the neo-Kantian line of criticism resides in the objections expressed by von Kries in an 1882 essay. He held that natural scientific thinking is founded upon applications of the notions or pure intuitions of space and time, mathematically represented, to physical quantities. Mathematics determines the inner relations, especially the concept of equality. Measurement fundamentally concerns the equating of nonidentical objects according to a common standard, such as a measuring stick and a length of string. To be applicable in science, such a measuring regime must be shown to be meaningful. In the case of measuring mass (a much less trivial undertaking) it requires, according to von Kries, a stipulated standard, a classic example being a balance with standard masses. As noted above, a feature that functions as a sign of objective

measurability is the property of additivity. Two masses defined as equal come out equal on the measure, and so do multiples of the basic units. Von Kries argues that for physics, in the last analysis, "only values of length, time, and mass are compared one to another, and the reduction of all other values to these is mediated by an expedient definition that takes the factual relations into consideration" (von Kries 1882, quoted in Heidelberger [1993] 2004, 227). Such definitions guarantee objectivity.

These points put into place the basic elements of von Kries's critique of Fechner's notion of sensation as an intensive value. What would be needed for sensations to be possibly objective values is equality among sensations or measurements of sensations. But, clearly, argued von Kries, sensations lack the "kind of sameness that elements have, an equality that is characteristic of our notions of space and time" (1882, 267). As with Tannery's view, sensations are not here thought to be homogeneous. The values of wholes are meaningful only if the part values of the same kind add up to the value of the whole. So, a loud sound would have to be a sum of quiet sounds like a foot is the sum of twelve inches. Von Kries thought that one would need to define sensations (as in the case of mass) in terms of some legitimate unit, such as space, time, or mass. But he concluded that any such definition would be simply arbitrary and thus worthless as an objective scientific measuring unit. For how could we choose in good faith between making the basis of the measurement of sensations the just noticeable difference (*jnd*) or equal increments of stimulus magnitudes? The two measures yield different results, but there appear to be no principled reasons to choose one over the other. Two standards would yield different units of "equal" differences in sensations. So it is just as meaningless to try to equate one sensation with another as to try to equate a centimeter and a second. He concludes that intensive magnitudes are not measurable because they cannot be defined consistently in terms of space, time, and mass. He agreed with Tannery that Fechner had confused sensation with "objective" stimulus values (Heidelberger [1993] 2004, 228).

Fechner responded to the criticisms in a number of places (Fechner 1882; 1887; cited in Heidelberger [1993] 2004). However, I follow Heidelberger's discussion here and consider briefly Ernst Mach's views on measurement as a gloss on Fechner's original measurement principles. If Mach can show that one can articulate a theory of measurement that makes sense out of Fechner's claims to measure sensations, this may help to establish at least a plausible case for a moderately independent status of Fechner's basic hypothesis. In the neo-Kantian framework, for example with Cohen, there appeared to be a lingering hope to trace all empirically measurable quantities back to purified intuitions of space and time. Mach attempted to devise procedures to show that all measurements ultimately rely on sensations and find intersubjectively reliable standards. How one was to go about establishing the standard relied less on tracing things back ultimately to

space and time than on establishing intersubjective reliability for the interests one intended to pursue (such as measuring temperature).

In the *Analysis of Sensations* (1886, 1, 34) Mach argues that physics cannot do without sensations of color, sound, heat, pressure, space, and so on. Space, time, and mass are just sensory elements among other sensory elements. One could take this as a statement of a radical phenomenalist thesis or simply a claim about empirical accessibility. For our purposes, the methodological aspect is of primary importance. Mach distinguishes physical quantities from psychological and psychophysical in the following way. The physical are those sensory elements that appear to be outside our bodies; the psychological, those within us; and the psychophysical, those crossing the boundary between inside and outside. His basic approach to measurement is to take a class of sensations and find a numerical representation of an external observational element that can serve as a feature of any sensation. Furthermore, the two quantities should change in a clear functional relation; as the sensation becomes stronger the "external" feature increases. So, objective equality rests upon the comparison of two distinct sensations.

In the *Principles of the Doctrine of Heat* (1896) Mach articulates a basic temperature measurement. We first need to identify certain volumes that change reliably with changes in temperature. We pick something like the expansion of mercury to measure heat changes, because it helps physics to discover characteristics of our sensation of heat so that science can make productive, simple, and ordered claims about the relations existing between this characteristic and others experienced in the world. Mach outlines a few criteria to carry out such a functional coordination in the case of temperature measurement.

1. Determine a thermoscopic substance the expansion of which is related to the state of heat of some other matter.
2. Define equality of heat—that is, define under which circumstances a quantity of some material has the same temperature as a standard quantity of a standard substance. For example, find a volume element of mercury that represents 0° C and 100° C, matching, respectively, the freezing and boiling points of water at a standard pressure.
3. Find a point of agreement on a principle of correlation. Establish a definite functional correlation for assigning number series, the elements of which function as the temperature of the substance to various volumes of the standard substance.

Understood this way, measuring a magnitude could be conceived as the discovery of a relation, say, between the thing measured and a standard of measurement (see Heidelberger [1993] 2004, 236–37). With space and time we may simply have sensations that are correlated with measuring rods and clocks. The choices made as to which correlations are relevant stem from attempts to optimize intersubjective comparability.

On the basis of these principles Mach (with Fechner in principle) formulated the following response to the neo-Kantian critics of Fechner's program of measuring sensations. First, homogeneity and additivity cannot be viewed as strictly necessary criteria for measuring magnitudes. Against von Kries and Tannery, Mach argued—it is practical to substitute the equality of magnitudes with the equality of length (for example with the thermometer), but it is not necessary for objective measurement. We can formulate a notion of equality of heat and cold to serve various purposes without reducing heat sensations to a certain length (of a mercury column, for example) and thereby making the sensations "extensive" (Heidelberger [1993] 2004, 245).

The resolution of the debate concerning alternative approaches to the measurement of sensation would hopefully be resolved by the long-term success (or failure) of applying the various conceptions to a whole range of empirical projects. It seems sensible to recognize that central players in this ongoing dispute about the measurement of sensations had broader philosophical agendas—the neo-Kantians, Fechner (the Day View), Mach (phenomenalism). However, the resolution of the debate did not hang on allegiance to any particular philosophical agenda—at least it does not seem to have been determined by allegiance to such agendas, much less to questions of specific religious agendas.[10] Decades of work in psychophysical studies have attempted to determine the degree to which sensations themselves can be meaningfully or clearly measured (and maybe they cannot). Einstein's theory of special relativity helped to vindicate some of Mach's arguments about the determining of spatial and temporal magnitudes through measurement protocols based in comparisons of sensational elements rather than appeal to pure a priori intuitions of space and time. Of course, there were enormous debates (and they still go on) about the nature of space-time in relation to modern physics.

Thus, when assessing Heidelberger's observation ([1993] 2004, 244) that Fechner's Day View is implicated in the theory of measurement, it seems more appropriate to credit it a role in the context of discovery and in the short-term debate about justification than in the long-term debate. As Mach weighed in, the Day View as such seemed to fade somewhat into the background. Fechner and Mach shared convictions that sensations are measurable. They denied there being in principle distinctions in the measurability among different domains such as *jnd*s (for example of color intensity), sensations of heat (such as temperature measures), and sensations of length (comparing lengths with rods and objects). Both held that in scientific measurement protocols, evaluation of subjective magnitudes is not only meaningful but necessary. Physics as such, they argued, cannot dispense with sensations as part of the measurement process. Mach took this in a very different direction than did neo-Kantians in his explanation about the reasons behind changes in measuring procedures in the history of human

inquiry (Heidelberger [1993] 2004, 245). So at the end of the day it seems fully appropriate to discuss the background philosophical commitments in making sense of the various proposals on measurement theory and psychophysics. These clearly were important issues in the minds of the principal contributors.

However, it seems implausible to me that the resolution of the key questions about measuring sensations depended much at all on the specific tenets of either neo-Kantianism or the Day-View. Furthermore, the empirical resolution of such questions helps to support setting aside not only more purely epistemological commitments about ultimate warrant (neo-Kantian versions of pure intuitions, Machian sensations, and the like) but also highly contested views on the mind-body problem and related religious questions about the nature of the soul. Methodological issues in sensory psychology increasingly have demanded experimental and observational answers to the more and more precise questions asked of the practitioners. This does not mean that the big-picture questions are completely out of play; rather, the debate proceeds to various forms of resolution without having to settle such questions. This approach does not pay tribute to some naturalistic agenda. On the contrary, it seems a sensible epistemic agenda has driven the marginalization of fundamental philosophical and theological questions from this domain of psychology while supporting methodological naturalization.

Lotze's Model of Dialogue

As David Sullivan nicely describes it, Lotze's method of philosophy involves a peculiar dialectic, attempting to give every competing side of a question its full due yet in the synthesis transforming each member of the antithesis. His approach exhibits "a striking modernity in his patient discussions of competing approaches to various 'problems,' one that proceeds without regard to their source in physiology, psychology, or philosophy of mind" (Sullivan 2005, section 2). Lotze's sprawling, three-volume *Mikrokosmus* appeared in several parts from 1856 to 1864. It attempts to integrate science, philosophy, and philosophical theology into one framework. In the introduction to the work Lotze duly recognizes the tremendous advances that science has enjoyed in "subjecting various regions of nature to law" (Lotze [1856–64] 1899, viii). However, he observes that this success threatens to distort in a new way what he considers a "juster relation" between cognition and spiritual needs. There is a tendency to confuse the ability to succeed in science while setting aside the major questions of ultimate meaning, value, and hope with a denial that "there is any obligation to return to these questions at all in the course of investigation" (p. viii). In his words, there is a passage "from timidity to tempestuous boldness." He makes the point that science exists in the very convictions of those who are

persuaded of its truth, and that those regions it investigates are regions of firm prior commitments on the part of those not privy to the details of what science has to teach on the matter.

> Science always comes too late to meet with a neutral reception. . . . Though a man may revel in this faith in the world of feeling, he cannot avoid making use of the advantages of science at every step in practical life, and thus tacitly acknowledging its truth; just as little can a man live for science without experiencing the joy and the burden of existence, and feeling himself everywhere surrounded by a cosmic order of another kind, on which science sheds at best but scanty enlightenment. Can the difficulty be evaded more easily than by trying to take part in both worlds, to belong to both, yet without uniting the two? ([1856–64] 1899, x)

He asks whether an independence view of science and faith addresses the tensions adequately and answers, effectively, No—one cannot simply take off the lab coat at the end of the scientific work week and don the garb of worship on sacred days. Although he holds little hope of building, by himself, a perfectly coherent harmony of both, "we must be ever consciously endeavoring to maintain the rights of each, and to show how far from insoluble is the contradiction in which they appear to be inextricably involved" (p. xi).

Lotze attempted to resolve the contradiction through the development of a comprehensive idealistic metaphysics predicated on a theory of value. The ultimately real being is ideal, that is, nonphysical. The physical world is a kind of outer manifestation of the ideal, and the multiplicity of individual things in the "real" world are at bottom parts of the one, true, simple, ideal reality. This simple, unitary, ideal being may be thought of as a personal God.

Rather than exploring the details of Lotze's metaphysical picture and concept of God, let me say a little about his conception of the human soul. He sees the human soul as an immaterial entity. He grants that the functions of our soul and its existence as a living entity are intimately bound up with the body and its processes. However, he repeats in several places that the fact that conscious experience exists at all testifies to a deep unity of the soul. He argues that there need not be consciousness of unity, for any conscious experience at all requires unity, even if the experience itself is wholly chaotic and disjointed.

I do not evaluate his argument here but simply note that his approach to psychology and physiology from early in his writing in the 1840s shows keen interest in details of the physiological side of psychological experience. Lotze clearly advocated the detailed empirical investigation of the physical and physiological correlates of psychological experience. However, he insists in numerous places that the study of the lawful nature of that side of human existence must be completed in a philosophical (and ultimately theological) account of the meaning of the existence of the psyche as the soul. That is, in principle, the ground of human value and meaning

lies beyond what science and the study of natural law can yield, even if a science of psychology may depend in deep ways upon the science of human physiology. I reflect below on the role his conception of the soul played in his best-remembered psychological hypothesis, the theory of local signs. In short, the commitment to a philosophical account of the human soul had a significant impact on Lotze's formulation of his thesis of local signs to explain basic aspects of human spatial perception. And Lotze's hypothesis helped to focus a significant degree of discussion on this problem as physiological and experimental psychology took root in the latter half of the nineteenth century.

Lotze on the Soul and the Hypothesis of Local Signs

Lotze's influence on the development of psychology in the mid- to late nineteenth century was significant. Especially with his influential study *Medicinische Psychologie* (1852), he made contributions to what Hatfield appropriately calls a disciplinary transition (rather than the usual "formation" language) of psychology as an experimental science.[11] Lotze was primarily a philosopher, holding the chair at Göttingen from 1845 to 1880 and then briefly answering a call to Berlin in 1881 but tragically falling gravely ill (of pneumonia) that same year. He contributed to the discussion of the relation of philosophy and psychology both by his highly influential systematic work in post-Idealist metaphysics and with his specific contributions to outlining a project of physiological psychology. He argued throughout his professional life for the epistemic and metaphysical priority of a philosophical doctrine of the soul as fundamental to the study of human cognitive function and reality. This helped pave the way for opening the scientific territory by his own insistence upon philosophizing in dialogue with the experimental investigation of the "soul" or mind.

Lotze's insistently metaphysical approach to physiological psychology has been cited by early commentators (Ribot 1886) and later ones (Boring 1950) as reasons to exclude Lotze from the cohort of founding members of experimental psychology. His status as an important forerunner of the new "experimental" psychology is not in dispute. On the contrary, we will see that being an idealist and antinaturalist in metaphysics did not hinder his advocating a naturalistic approach to the study of spatial perception or his hypothesis of local signs being taken up by a string of investigators who did not share Lotze's metaphysical commitments.

The local sign hypothesis was significantly motivated by a layer of basic commitments. Of primary importance is Lotze's view of the soul. He thought that perception as a conscious event takes place in the soul, a nonextended entity that has representations with a spatial, extended quality to them. One of these is the capacity to localize perceptual objects or parts of objects as spatially ordered. How can it be that extensive magnitudes or-

dered in "space" lead to purely intensive magnitudes in consciousness that lead to a perception of the spatial ordering, preserving the relationships? Lotze introduced the term "local sign" in his 1846 study *Seele, Seelenleben*, and developed it extensively in his 1852 one, to play an explanatory role for spatial vision akin to that of Johann Steinbuch's *Bewegideen* (Ideas of Movement) or C. T. Tourtual's special signs (Rollinger 2001, 108; Hatfield 1990, 158). A local sign is a qualitative feature of a sensation from the stimulation of a particular place on the retina or the skin. It was postulated as a way to explain the spatial ordering of tactile sensations and perceptions in consciousness. The need for an explanation, on Lotze's conception of the soul as the seat of consciousness, was that the soul is not a spatially extended entity, so the differences in sensational content as available within the soul would be of a purely qualitative sort. The quality of a local sign was thought to be constant and to manifest itself only when that specific location received stimulation. This might be likened to a stamp of particular origin, like a house address. However, the local sign is of a purely qualitative sort because it cannot depend on its spatial location, in consciousness, to determine its content. Lotze concisely summarizes:

> When we perceive the points *a, b, c*, in this order side by side, our consciousness sets *a* to the left and *c* to the right of *b*: but the *idea* of *a*, through which we thus represent *a*, does not lie to the left, nor the idea of *c* to the right, of the idea of *b*; the idea itself has not these predicates, it only gives them to the points of which it is the idea. And, conversely, if we still suppose consciousness to be a space, and further that the idea of *a* lies in it to the left of the idea of *b*, this fact would still not be the same thing with the knowledge of it. . . . How does the extended soul succeed in distinguishing these two points of its own essence, which at a given moment are the places where that essence is stimulated; and by what means does it obtain a view of the spatial line or distance which separates the two from one another? The connecting, referring, and comparing consciousness, which could perform this task, could never be anything but an activity which is unextended, intensive and a unity—even if the substantive being to which we ascribed this activity were extended. In the end the impressions would have to pass into this non-spatial consciousness; and therefore we gain nothing for the explanation of the perception of space by interposing this supposition,—a supposition which in any case is impossible for us to accept. (Lotze 1884, 251)

In his 1884 formulation, Lotze emphasizes that the stimuli exciting a particular nerve fiber give rise to the particular content associated with that nerve fiber, say a particular color impression. But there is an extra impression that connects itself by association to the first, without interfering with the content. By being so connected this extra impression, or local sign, might play its part in the realization of a coherent "spatial" ordering of sensory content in consciousness (Lotze 1884, 255).

Although the whole story is too lengthy to enter here, the local sign hypothesis took on a life of its own once Lotze developed it in some detail. Investigators as diverse as Hermann von Helmholtz (no explicit metaphysical views on the mind-body relation), Wilhelm Wundt (a psychophysical

parallelist), and Ewald Hering (a materialist) took up the discussion of the local sign hypothesis (Woodward 1978; Hatfield 1990). Lotze's version came under a number of distinct criticisms. One sort targeted Lotze's appeal to muscle movements as the source of the local signs associated with illumination of specific retinal locations. Carl Stumpf in an 1886 lecture argued that instantaneous illumination experiments showed that subjects can discern spatial magnitudes without a chance to move their eyes. Stumpf took this sort of experiment to show that local signs were unnecessary and that a form of nativism better explained this particular capacity. As with Fechner's proposals concerning the measurement of sensation, Lotze's hypothesis of local signs has a strong foundation in his picture of the soul and the person in the context of discovery, but the debate regarding its justification proceeded independently of these commitments toward a provisional resolution of the debate in the emergence of Gestalt psychology in the early twentieth century (Woodward 1978; Rollinger 2001).

Conclusion

I have aimed to show that the development of a methodologically naturalistic approach within sensory psychology was neither arbitrary nor primarily motivated by a metaphysically naturalistic agenda. As the nineteenth century progressed, investigators began to unravel in detail the physiological basis of human sensation and perception and to incorporate this systematically with related the psychological investigations. As the so-called scientific status of physiological psychology became more developed, it became attractive methodologically to formulate what I call moderately independent hypotheses. The success (clearly not perfect) has supported relegating many broader questions about the mind-body problem and the nature of soul generally to the sidelines of sensory psychology. This does not mean they are thereby solved or made meaningless. It appears more likely simply that they do not admit of solution using the tools of experimental and physiological investigation. This story helps to make sense of the increasing hold of naturalistic methods in psychology and suggests why the naturalistic approach may continue to make sense as long as investigators continue to uncover helpful insights about the nature of perception using the tools of physiological and physical investigations.

Notes

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1. Recent debates, particularly concerning evolutionary theory and rival Intelligent Design proposals, have questioned the role of methodological naturalism as a strong methodological principle in the evaluation of scientific models, theories, and ideas. Within the debate concerning ID and related calls for a theistic science from Alvin Plantinga, William Dembski, Michael Behe, Stephen Meyer, J. P. Moreland, and others, it has been suggested that methodological naturalism is a form of provisional atheism. A main goal of this essay is to raise doubt about this association.
2. For a survey of some such arguments see McDonald and Tro in press; Plantinga 1996; Ratzsch 2001; 2004; Stenmark 2004.
3. The development of methodological naturalism is a response to the growing sense that high-level metaphysical commitments (including theological/religious) play little role in the evaluation of scientific claims as the latter became increasingly specialized, precise, and empirically detailed. And this is fully consistent with such commitments playing roles in the context of discovery. They were not completely isolated from the evaluative process in the mid- and later nineteenth century in psychology, and some, including Lotze, brought in metaphysical presuppositions at crucial times. However, the growing sense was that metaphysical assumptions that could not achieve broad acceptance were no longer needed to do the work of supporting the experimental and physiological approach to understanding the senses.
4. For a more extended discussion of this point, see McDonald and Tro in press.
5. As noted in more detail below, local signs meant something different for Lotze than for Hermann von Helmholtz or Wilhelm Wundt, given other assumptions the latter held about the mind and the role of philosophy in physiological psychology.
6. This question relates closely to the ongoing discussion in the philosophy of science concerning meaning holism and incommensurability catalyzed by Thomas Kuhn's *Structure of Scientific Revolutions* (1970). The modularity thesis is consistent with weaker forms of meaning holism and incommensurability but conflicts with stronger forms of those theses. Furthermore, maintaining MN as a strong norm (if not definitional of science) requires a form of the moderate independence thesis but does not require a wholesale dismissal of holism and so forth.
7. See Heidelberger [1993] 2004, 73–115 (chap. 2), for an extended discussion.
8. I call this a philosophical theology because it is based (it seems) largely on Fechner's engagement with philosophical points of view within a broader religious framework rather than traditional Christian theology, which explicitly deals with the revealed tradition (sacred texts, church fathers, and the doctrinal traditions of the different Christian churches).
9. Interestingly, Lotze published his major contribution to physiological psychology in 1852. Fechner and Lotze were friends, having had a fair degree of contact in Leipzig, but I do not enter into a discussion of mutual influence here. Lotze had studied medicine, in part under Fechner and E. H. Weber. Fechner and Lotze formed two parts of a discussion circle in Leipzig that included the philosopher and quasi-Hegelian Christian Weisse. Lotze left Leipzig in 1844 to take up Herbart's chair in Göttingen. He and Fechner had had contact for nearly a decade.
10. Donald Laming offers a very detailed account of the history and ongoing significance of the debate concerning the measurability of sensation. He concludes that there is no internal sensation to be measured, that is, "no sensation distinct from subjective estimates of physical stimulus magnitudes." Observers, in other words, do estimate the value of stimulus magnitudes but do not in perception estimate the value of some internal intermediary that itself could be measured (1997, 27). Despite this somewhat pessimistic conclusion, Laming's general mode of argumentation seems to vindicate the thesis of this essay. Indeed, extra-empirical commitments have driven the debates about psychophysics and indeed have played a part in the persistence of different models of the measurability and measurement of sensation. However, the attempts to resolve such disputes continue to occur with dependence not on deep philosophical or theological commitments but rather on the ability of the model of measurement to be empirically and experimentally adequate.

11. For a detailed discussion of Lotze's contributions to the formation of a scientific sensory psychology see Woodward 1978; Hatfield 1990; 1997; 2002; Lenoir 1993; Rollinger 2001.

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