

PSYCHOPHYSICS, OR ALGEBRA OF PRIMARY EXPERIENCE?

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Abstract

The foundational idea of psychophysics is the study of psycho–physical relations in a non-dualist paradigm. We attempt to revive the original motives of psychophysical science in a series of reflections on selected themes: Fechner’s original idea of psychophysics, Mach’s programme of a unitary psycho–physical science, and later attempts (phenomenology, protophysics) to establish a scientia prima, conceiving law-like, invariant structures of the world as given in primary experience. We conclude with a proposal for an ‘integral psychophysics,’ which is here defined as a mathematical study of structures of primary experience.

“Nun aber, wie werde ich mit meinem bischen Mathematik dieß neue große Gebiet beherrschen können? Beherrschen gewiß nicht; aber doch vielleicht beginnen. [...] Aber den Fortbau freilich werde ich Andern überlassen müssen.” — G. Th. Fechner [1, p. 410]¹

Psychophysics is nowadays understood as a part of experimental psychology, providing methods for studies of sensory processes and/or higher cognitive functions [2], and fairly detached from the philosophical views of the “founding father,” G. Th. Fechner, and of his successors [3]. Here we shall argue that the original ideas of psychophysics should not be just left behind, but rather re-thought in the modern context and re-integrated into the working programme of psychophysics.

Fechner and Mach: Two concepts of a psychophysical science

According to Fechner’s definition given in his *Elements*,

“[p]sychophysics should be understood ... as an exact theory of functional relations or dependence relations [*Abhängigkeitsbeziehungen*] between body and soul or, more generally, between the material and the mental, the physical and the psychological worlds.” [4, p. 7]²

The ‘two-worlds’ diction refers to two phenomenal realms and does not imply any ‘ontological’ dualism.³ Fechner insisted that psychophysics “concerns itself only with the phenomenal relationships” and does not refer “in any way to the nature of the body or of the soul ... in the metaphysical sense,” that is, “beyond the phenomenal.” Yet, he went further than that with his conception of a *unitary reality* beyond the appearances, a sort of ‘dual-aspect’ identity theory, based

“... on identity of what appears double from from two standpoints. A theory of the relationship of mind and body will have to trace the relationship of the two modes of appearance of a single thing that is unity.” [4, p. 5]

Fechner explicated his double-aspect interpretation of the mental and the physical in the famous metaphor: viewing a circle from inside or from outside, we can see either the concave or the convex surface, “both sides belong together as indivisibly as do the mental and material sides” [4, p. 2]. We have two appearances of the same entity, unity of which can be *inferred* from the relation between curvatures $k_{\text{in}} = -k_{\text{ex}}$ (Fig. 1a). In (our) slightly modified version, local curvatures k_1, k_2 in the two alternative views give $k_1 + k_2 = 0$ at any point P, P', P'', \dots on a curve (Fig. 1b). So we have an *observational invariance*, that is, a prototype of an empirical ‘law’ [5].

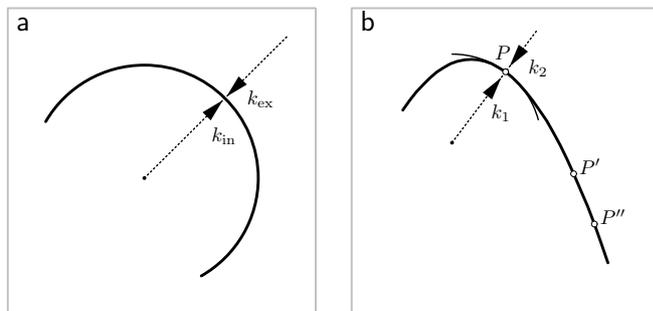


Figure 1. — (a) Fechner's circle metaphor. (b) Fechner's metaphor, modified: relation $k_1 + k_2 = 0$ between local curvatures holds across all points P, P', P'', \dots on a curve.

Fechner sought to “illustrate this [psycho–physical] relationship ... by means of a mathematical function, an equation between the variables x and y , where each variable can be looked upon ... as a function of the other” [4, p. 8]. In Fechner's psychophysics, the rôle of such functional relation between the physical and mental domain is played by the well-known logarithmic formula.⁴ But, as Fechner's critics objected (*cf.* [6], p. 207ff), his formula is a *definition* of a measure of the ‘mental,’ not an empirical finding; it is a prescription, not a description.

Ernst Mach's views can be seen as a daring extrapolation of the original idea of Fechner's psychophysics.⁵ He, too, wants to dissolve the traditional psycho–physical dualism, but

“the view here advocated is different from Fechner's conception ... [O]ur view has no meta-physical background ... We refuse to distinguish two different aspects of an unknown *tertium quid*; the elements given in experience ... are always the same, and are of only one nature, though they appear, according to the nature of connexion, at one moment as physical and at another as psychological elements.” [7, p. 61]

In Mach's conception, there are no two realms to be related; there is but *one* realm, and the illusion of the two domains arises from the existence of two relatively stable relational systems, or “connexions” [*Zusammenhänge*] between the elements:

“There is no rift between the psychical and the physical, no inside and outside, no ‘sensation’ to which an external ‘thing,’ different from sensation, corresponds. There is but one kind of elements ... which are themselves inside and outside, according to the aspect in which, for the time being, they are viewed. The sensory world belongs both to the physical and the psychical domain alike.” [7, p. 310]

The notion of ‘element’ is as essential for understanding of Mach's thought as it is notoriously difficult to grasp. Mach's elements are *not identical with* ‘sensations’ of any particular subject; importantly, the elements are *not (yet) mental* by the same token as they are *not (yet) physical*.⁶ Consequently, the elements are neutral as well with respect to the subject–object distinction. This is why Fechner's ‘dual-aspect’ theory, implying a subject *to whom* the ‘inside’ vs. ‘outside’ distinction applies, does not work for Mach. In Mach's view, ‘ego’ is merely a name for one relatively stable aggregate of elements, nothing like a ‘mysterious entity’ existing somehow independently of the elements, which is for Mach a plain superstition.

Mach's thought thus leads up to negation of Fechner's ideas. Mach is expressly anti-metaphysical where Fechner is elusively non-metaphysical (or rather crypto-metaphysical).⁷ For Fechner, psycho–physical dualism arises from duality of ‘perspectives’; for Mach, from duality of ‘connections.’ Fechner's psychophysics is a bridge between physics and psychology; Mach's unitary science would be an overarching structure, comprising the two sciences as special cases:

“psychology [and] physics ... mutually support one another, and it is only when they are united that a complete science is formed.” [7, p. 341]

Fechner and Mach still have in common the notion of interdependence between phenomena, to be expressed mathematically as functional relations. But even here the emphasis is put differently: for Fechner, it is the existence of ‘something’ behind the appearances that manifests itself in an observed invariance, while for Mach, the invariance relation *itself* is ‘some thing’; and so

“[e]verything that we can want to know is given by the solution of a problem in mathematical form, by the ascertainment of the functional dependence of the sensational elements on one another. This knowledge exhausts the knowledge of ‘reality.’” [7, p. 369]

Mach also used (as Fechner before him) a kind of mathematical metaphors; he used to write $F(\alpha, \beta, \gamma, \dots, \omega) = 0$ to express the interdependence between elements, making up the universal functional nexus of Nature (see [8], p. 604; *cf.* also [9], p. 126). This, of course, is no meaningful equation of physics; rather a symbolic expression modeled by the general form of physical laws, where α, β, \dots are physical quantities. But, accordingly to Mach’s concept sketched above, if we have some ‘local’ grouping of psychophysically neutral elements into ‘physical invariants,’ $\phi_i(\alpha, \dots, \omega)$, or ‘mental invariants,’ $\psi_j(\alpha, \dots, \omega)$, then the functional form F could be re-written as $G(\phi_1, \dots, \phi_m, \psi_1, \dots, \psi_n) = 0$. Fechner’s notion of a psychophysical law of the form $F(x, y) = 0$, or, explicitly, $y = f(x)$, is a special case of a more general concept Mach’s.

From ‘pure experience’ to structures of ‘life-world’

Mach’s neutral elements are reminiscent of W. James’ notion of ‘pure experience,’ which is supposedly the “only one primal stuff or material in the world, a stuff of which everything is composed” [10, p. 208]. James says, in almost exactly Machian diction, that “[e]xperience ... has no inner duplicity; and the separation of it into consciousness and content comes ... by way of addition ... of other sets of experiences, in connection with which ... its use or function may be of two different kinds.” [10, p. 210] Similar views were expressed by B. Russell [11] and other philosophers subsumed under the title ‘neutral monism’ [12]. While this may be an interesting metaphysical stance, it is not of our prime concern; our question is whether, and how, this psychophysically neutral view can serve as a basis for a positive science.

First, a change of perspective is required (i) to put aside the thought habits and petrified language constructs of psycho–physical dualism, and (ii) to unveil the world of primary experience as a field of psychophysically neutral phenomena. This change of perspective is roughly equivalent to phenomenological *epoché*,⁸ employed by the late Husserl to discover the domain of pre-scientific experience—the *Lebenswelt* (‘life-world’) [13, §34ff]. In this perspective, the ‘reality status’ of presupposed physical or mental connections is suspended, while their phenomenal character is preserved. As a result, we have the world as a psychophysically neutral phenomenal field, as given in primary experience, at a point preceding the intellectual dichotomy of the experienced into objective being and subjective appearance. Importantly, we find the world of primary experience ‘as is,’ that is, a *structured field*, not as an amorphous mass of ‘elements’ *sensu* Mach.

If a rigorous science operating on this neutral ground is possible, the ‘matter’ of its interest are structures of primary experience (things or invariants of higher order: situations), followed up to the bifurcation from where on descriptions of the content of experience in terms of the ‘physical’ or the ‘mental’ become an economical alternative. In this enterprise, ‘elements’ may play an auxiliary rôle as *abstractive moments* of experience, not its ‘stuff’ or ‘substance.’⁹

In this perspective, physical reality (matter) is not the foundation and condition of experience, but rather a complex of coherent descriptions, derived from and constituted upon the primary experience of the world. There is, obviously, a certain parallelism with the programme of *proto-physics*,¹⁰ which is a study of axiomatic bases of physics and geometry as derived from human technical *praxis*. Briefly, protophysics searches the answer to the question “How is the rationality of physics possible?” [14] in the structure of *intersubjective* experience of the material world—which fits well with our phenomenological perspective. — Here we should mention another sympathetic line of thought, originating in philosophy of mathematics: F. Gonseth pointed out the

“necessity of a rudimentary physics which would take into account only the very apparent characteristics of phenomena, a totally naïve physics, in which our sensory impressions would be directly interpreted as evident symptoms of *practically verified reality*.” [15, pp. 60–61]

Such a field of study would, in Gonseth's words, establish a "first chapter of science," which would not be an autonomous, closed discipline, but "should be *open* simultaneously toward exact sciences and psychology" (*loc. cit.*). — In sum: not physics and not psychology; rather a *scientia prima* of the prime matter of knowledge, which is experience of the world 'as is.'

Towards an 'integral psychophysics'

In the preceding sections we have reviewed the original motives of Fechner's psychophysics, sketched Mach's revision of those ideas, and seen the idea of a unitary science on a psychophysically neutral ground emerging in various contexts. At present, nowhere in the given disciplinary structure of sciences this idea is consequently continued. Here we suggest that this task should be resumed at the very locus of its origin, that is, in psychophysics, properly redefined [16].

We define *integral psychophysics* as a systematic study of elementary structures of primary experience, independent from and prior to its conceptual division into the physical and mental domains. Therefore, this study should not be part of or dependent on physics or psychology, but rather preceding these two sciences as a propædeutic discipline.

Integral psychophysics should be a mathematical, not only 'mathematised' science; that is to say, *essentially mathematical*, not only measuring and in this sense 'quantitative.' Quantification of experiential dimensions is and remains an important task for psychophysics; but, prior to this, and more importantly, the proper subject of psychophysical study are the *conditions of measurability*, that is, the underlying algebra, not the surface arithmetics. Of special interest is the emergence of sensory dimensions, which can be perhaps modeled and understood as a result of a 'natural factorisation' of primary experience.

Concluding remarks

This proposal for 'integral psychophysics' is necessarily just a programmatic sketch; a few explanatory remarks follow, as far as space constraints allow.

Psychophysics and physics. The proposed conception of integral psychophysics is in line with Mach's premise, "physics is experience, arranged in economical order" [17, p. 197]. The task here is not to 'explain' experience but rather to understand "how it comes about that within the whole domain of experience a selected portion is capable of that exact metrical representation which is requisite for development by the scientific method" [18, p. 275].

This view, however, conflicts with the still influential notion of physics as a study of the ultimate reality (matter in motion) and its laws, out of which *all* phenomena, including the fact of conscious experience, shall be eventually 'explained.' In our opinion, the fashion of physicalist reductionism is a temporary deviation of *zeitgeist*, which shall be replaced by a more balanced world-view. The present situation of sciences may be more favourable to such a change of perspective than the 20th century, as the plain physicalism seems to fade out, and the need for a broader conceptual framework accomodating physical, biological and psycho-social phenomena on a non-reductive basis is widely recognised. The link between integral psychophysics and physics amounts to a 'methodological,' but not 'ontological' physicalism [5, p. 424].

Psychophysics and psychology. Experimental psychology was born out of psychophysics and accomodated psychophysical methods to its purposes. We wish to argue, however, that psychology has been a temporary shelter for psychophysics, not its proper home. Indeed, for integral psychophysics concepts such as sensations, percepts, or cognitive processes are no experienced reality, but theoretical constructs, as are elementary particles, molecules, or force fields in physics. We want to avoid both reductionist temptations, physicalism as well as 'psychologism'; the latter more intricate, as it relies upon a wide-spread misconception of experience as something 'mental.' *Primary experience is psychophysically neutral*; psychology operates on abstractions derived from

experience, but has no direct or privileged access to it.

Our understanding of psychophysical experiment should be accordingly revised. For instance, in integral psychophysics there is no place for sensations or percepts as ‘mental entities,’ properties of which would be ‘measured.’ An experiment is a variety of world configurations co-arranged by the experimenter and the participant; the latter’s rôle is to detect sub-manifolds of ‘sensory equilibria’ in the space of possible configurations. The so-called ‘measures of sensations’ are merely numerical indices, assigned by some meaningful rule to the experimental configurations; ‘psychophysical laws’ are just mathematical expressions of such experiential invariants. In this way, difficulties inherent to the notion of ‘measurement of the mental’ are avoided.

Philosophical aspects. Although this paper is concerned primarily with psychophysics, not with philosophy, some implications should be mentioned. We believe that taking primary experience as the first reality, upon and out of which special sciences (physics, biology, psychology) are built, leads to a robust, no-nonsense realism, and avoids various pseudo-problems and vain attempts of their solution. For example, the so-called psycho–physical problem in its ‘relational’ version may yield productive questions, whereas its ‘ontological’ variant is a sheer no-question. Here, the neutralist approach of integral psychophysics circumvents the trap, and helps to focus on meaningful and actually tractable problems.

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Notes

¹ “Now, how can I master this new large field with my little bit of mathematics? Certainly not master; yet perhaps set the beginning. [...] But I will have to leave further elaboration for others.” (transl. by J. W.)

² Minor imperfections of the American translation [4] tacitly rectified.

³ To this and the following paragraphs cf. Ch. 5 and 6 of Heidelberger’s monograph [6].

⁴ Fechner’s ‘measurement formula’ [*Maßformel*], derived in the 2nd volume of *Elemente* via integration of Weber’s law, and usually considered the ‘corner-stone’ of his psychophysics. But it is possible that Fechner originally conceived a more general idea. The report on Fechner’s celebrated ‘revelation’ (October 22, 1850) was written *post hoc* and is quite unclear. In his diary [1, p. 409f] as well as in the ‘Outline’ [19], Fechner is preoccupied with summation of increments of energy [*lebendige Kraft*] giving rise to a sensation, but he never refers to Weber’s law (cf. also [3, p. 198]). It seems that Fechner’s insight was elicited by the relation between arithmetic and geometric series, employed as another metaphor for the psycho–physical relation in *Zend-Avesta* (not included in [19]). We conjecture that Fechner already had an intuitive idea of *isomorphism* between the physical and the mental domain, that is, a correspondence between two *functions*, not just between numerical values. For an experimental physicist of the mid-19th century, such a notion must have been elusively abstract; and so Fechner could not but cast the idea of a psycho–physical functional relation to the form $y = f(x)$, by analogy with known laws of physics. — Our reading of Fechner thus reveals two lines of thought: (i) speculative and metaphorical, based on the idea of isomorphism, exposed in *Zend-Avesta* (1851); (ii) positive and empirical, based on the *Maßformel* and developed in *Elements* (1860); the latter may be only a distorted version of Fechner’s original vision, because of limitations of his mathematical apparatus.

⁵ As to Mach’s emancipation from Fechner’s influence, cf. Heidelberger [6, Ch. 4] and Banks [9, Ch. 6].

⁶ Mach himself contributed to semantic confusion by occasionally using the word ‘sensation’ [*Empfindung*] as a synonym for the ‘element.’ For further interpretation of Mach’s ‘elements,’ see Banks [9, Ch. 7] and [20].

⁷ Or, in Heidelberger’s [6, p. 162] concise phrasing, “Mach played Fechner, the psychophysicist and anti-metaphysician, against Fechner, the atomist and metaphysician.”

⁸ Of interest is here not so much the total or ‘transcendental’ *epoché*, but rather a so-called partial *epoché* from ‘objective sciences’ and their results.

⁹ This may be read as an ‘anti-metaphysical remark’ addressed to Mach himself.

¹⁰ Protophysics, founded by German mathematician and philosopher Hugo Dingler (1881–1954) and little known outside of German-speaking countries, has significantly contributed to the understanding of conceptual/instrumental conditions of measurements of extensive quantities such as length, duration, and mass [21]. Psychophysics, as we believe, may facilitate a protophysical approach to those physical continua which are based in special sensory domains (visual, tactile, *etc.*).

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