References

Blake, D. T., Hsiao, S. S., and Johnson, K. O. (1997). Neural coding mechanisms in tactile pattern recognition: the relative contributions of slowly and rapidly adapting mechanoreceptors to perceived roughness. *The Journal of Neuroscience*, *17*, 7480-7489.

Bensmaïa, S., and Hollins, M. (2005). Pacinian representations of fine surface texture. Perception & Psychophysics, 67, 842-854.

Bolanowski, S. J. Jr., and Verrillo, R. T. (1982). Temperature and criterion effects in a somatosensory subsystem: a neurophysiological and psychophysical study. *Journal of Neurophysiology*, *48*, 836-855.

Connor, C. E., Hsiao, S. S., Phillips, J. R., and Johnson, K. O. (1990). Tactile roughness: neural codes that account for psychophysical magnitude estimates. *The Journal of Neuroscience, 10,* 3823-3836.

Hollins, M., Bensmaïa, S. J., and Washburn, S. (2001). Vibrotactile adaptation impairs discrimination of fine, but not coarse, textures. *Somatosensory & Motor Research*, *18,* 253-262.

Miyaoka, T. (1994). Module mechanisms in tactile sensation. *The Bulletin of the Shizuoka Institute of Science and Technology, 3*, 85-98. (In Japanese with English abstract)

Miyaoka, T. (2004). Measurements of detection thresholds presenting normal and tangential vibrations on human glabrous skin. *Proceedings of the Twentieth Annual Meeting of the International Society for Psychophysics*, 465-470.

Miyaoka, T., Mano, T., and Ohka, M. (1999). Mechanisms of fine-surface-texture discrimination in human tactile sensation. *The Journal of the Acoustical Society of America*, *105*, 2485-2492.

PSYCHOPHYSICAL EXPERIMENTS AND PERCEPTUAL SITUATIONS

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Abstract

According to a widely accepted view, our percepts of the 'external world' consist of 'sensations', which are mental counterparts of physical properties of the perceived objects. Fechner's notion of 'measurement of sensations' is compatible with this view. We propose a re-interpretation based on our concept of psychophysics as a science of 'primary experience'. Psychophysical experiments are then understood as perceptual situations, consisting of a construction (apparatus) and an instruction given to the subject. 'Sensations' are conventional indices for classes of perceptually equivalent configurations (states of the apparatus), where the equivalence relation is specified by the instruction. In this account, the locus of the measured is in the inter-subjectively shared, commonly accessible, that is, communicable world—not inside the subject's mind.

Psychophysics, by Fechner conceived as "an exact theory of functional relations between ... the material and the mental, the physical and the psychological worlds" [3, p. 7], began with studies of elementary sensory processes. Fechner's measurement formula [*Maßformel*] posited a logarithmic relation between the physical magnitude of a stimulus and the intensity of a sensation [*Empfindung*] corresponding to the stimulus. On this basis, psychophysics was understood as 'measurement of sensations' [3, 4], a notion which propagates through the history of psychophysics until present days. In this paper[1] we take a closer look at the structure and meaning of psychophysical experiments, and propose a re-interpretation based on the concept of communicable perceptual situations.

The problem of measurement of sensations

According to Fechner's 'dual aspect' world-view, there is no primacy of the physical or the mental domain over its counterpart. Consequently, the relations between the two domains are conceived as bi-directional and, in principle, invertible:

> Insofar as a functional relationship linking body and mind exists, there is ... nothing to prevent us from ... pursuing it from the one direction rather than from the other. One can illustrate this relationship ... by means of a mathematical function, an equation between the variables x and y, where each variable can be looked upon at will as a function of the other ... [3, p. 8]

To express the functional relation mathematically, *e. g.* in the form $y = f(x)$, the values of x and y have to be specified numerically, that is, measured. Here Fechner admitted, not quite consistently with the above-quoted statement, that

> it is only the physical that is immediately open to measurement, whereas the measurement of the psychical can be obtained only as dependent on the physical ... [t]his reason ... determines the direction of approach ... [*ibid.*]

Fechner maintained the notion of mental measurement against vehement criticism until his last days.[2] However, the *operational primacy* of the physical over the mental did not escape the attention of Ernst Mach, who remarked:

> Even if Fechner with his psychophysics succeeded to measure individual sensations, we can have doubts about the meaning of this measure. ... Fechner's measure is perhaps more of physical than psychical nature. [9, p. 58][3]

This remark puts in question the locus of psychophysical measurements, and with this the very notion of 'sensation measurement'. To pursue the problem further, we may first ask:

Where and what are sensations?

In our perception of the world we usually recognize qualitatively distinct, relatively independent experiential moments: "Sensations refer to certain immediate and direct qualitative experiences—qualities or attributes such as 'hard', 'warm', 'red', and so on—produced by simple ... physical stimuli." [11, p. 1] Traditionally, sensations or (in philosophers' parlance) 'sense data' are conceived as the 'stuff' of our perceptual experience; in popular phrasing, we experience our sensations of things, not things as they are.[4] As far as 'things as they are' belong to the objective, physical reality, sensations are non-physical, *ergo* mental entities. Yet, sensations are real insofar that they are subjectively experienced; moreover, psychophysics claims that sensations can be measured.

The concept of sense data as a projection screen inserted between our perceiving minds and the real world was deservedly and ardently criticised [1, 10]. Saying "I have a sensation of red" does not mean that I really 'perceive' something called 'sensation of red'; it is is merely an awkward expression of the fact that "I see something red". Also, the sense data-account of perception is at odds with the phenomenology of our perceptual experience: we perceive real things in their totality, not just aggregates of volatile sensations. There is no compelling evidence that percepts are really 'composed' of elementary sensations—a view explicitly denied by Gestalt theories. Sensations are no-things;[5] nothing but abstractions from a percept, obtained by an effort of attention.

This criticism motivates a turn towards a robust realism of direct or 'primary' experience, as suggested by the programme of integral psychophysics [12]. But then the question arises: What happens with the concept of 'sensations measurement'? If this turns out meaningless, what do we really do in psychophysical experiments?[6]

Causal theory of perception

The mainstream of contemporary psychophysics adopts the standard theory of perception, based on a causal scheme (known from most introductory text-books):

$$\text{physical object} \rightarrow \text{stimulus} \rightarrow \text{receptor} \rightarrow \text{neural state} \rightarrow \text{sensation}\,. \qquad (1)$$

In this appealingly simple account, "you know the world from the energy your senses can intercept" [8, p. 1]. Thus we don't 'really' see a red strawberry; rather we have an experience of 'red' which is caused by an impact of electromagnetic radiation of a certain spectral composition on receptor cells in the eye's retina. The chain of *physical* effects goes all the way down to intra-cerebral processes; only at the very end of the chain that 'sensation' (a mental term in the physicalist description!) emerges, without causing much of philosophical headache. The sensory experience is somehow identified with the output from the sensory system, in a bold engineering metaphor.[7]

The standard theory thus maintains the traditional view of 'sense data', only enriching the picture with some details concerning the processes *preceding* the stage of sensory experience. The above-mentioned 'operational primacy' of the physical domain then simply reflects the essential asymmetry between a physical cause (stimulus) and a mental epi-phenomenon (sensation) of a terminal physical effect (neural state). But this is not the answer to the above-stated problem. Whether we are dealing with the stimulus–sensation relations ('outer' psychophysics) or with the neural state–sensation relations ('inner' psychophysics), the problem persists: how can we obtain access to the 'mental' realm in order to measure sensations?

Duality of perspectives

Fechner tried to illustrate the apparent duality of the 'mental' and 'physical' by a duality of views of a unitary reality, observed from an 'internal' or 'external' standpoint [3, p. 4f]; a notion reminiscent of the contemporary parlance of the first and third person perspective. In modern versions of the psycho-physical identity theory, the terminal instance in (1) appears from the private (1st person) perspective as a subjective sensory experience, and from the public (3rd person) perspective as a neural state, accessible to objective description in the physicalist language.

Now, if we apply this dual perspective scheme to the perceptual process (1) in its entirety[8], we immediately realize that from the first person perspective the whole chain is *transparent*. What is given to the perceiving subject is the object of perception itself; the single instances in the causal chain are distinguished only from the 'lateral', third person perspective. This seemingly trivial observation leads to a non-trivial question: What if neither the first nor the third person perspective is the primary one? Can we start from aligned perspectives of two or more subjects—let's say, '1st person plural' perspective—perceiving the same sector of the world?

Perceptual situations

Consider an everyday example: a car waiting at traffic lights; as the signal changes from red to green, the driver's companion B alerts the driver A, "look, green, go ahead!" Here, B is referring to an occurrence of the green light in the communicated world, not to her own or A's private sense-data. The communicative character of the situation can be simply expressed as "given that you can see what I can see" and verified by the fact of *practically efficient communication*, not by comparison of the two series consisting of A's and B's sensations (which is in principle impossible). Whether "A's 'green' is the same as B's 'green' " is totally irrelevant for the *agreement* between A and B upon the given situation.[9] In such situations, the perceived state of the world is, at the same time, the object and the carrier of inter-subjective communication.

Compare with a typical situation at the beginning of a psychophysical experiment: the experimenter E instructs the subject S, refers to identifiable elements in S's perceptual field and defines the task. — For example (Fig. 1c): "Can you see the two luminous patches? Now turn the knob until the patch on the left has the same brightness as the right-hand side patch." — The instruction relies upon the same premise as everyday communication: you (S) can see what I (E) can see. If S is reluctant about the instruction, E may be in doubt about the proper functioning of the apparatus and take the place of S to verify the appearance of the stimulus. For a successful experiment, the agreement upon 'what's there' in the world (instruction) is a condition as necessary as a properly functioning apparatus (construction).

After having given the instruction, E operates the apparatus, following an experimental protocol. Phenomenologically speaking, E varies the configuration of a given world sector to make S experience a variety of possible percepts; in a physicalist parlance, E 'prepares' stimuli of defined physical characteristics to be presented to S. Importantly, principles of physical measurement are built-in in the experimental construction, as will be seen below.

Measurement as a form of communication

Measurement is older than science; it is a cultural achievement, a special *form of communication*, intending inter-subjective agreement in situations such as distribution of territories, exchange of goods, *etc*. The agreement arises where *indifference* between different arrangements of things (world-states) is reached. All mutually indifferent world-states (w. r. t. a given purpose) form an *equivalence* class.

This general scheme is found again in physics.[10] The dimensional formula of a physical quantity (*e. g.* mass) identifies a class of natural phenomena of our interest (*e. g.* acceleration due to Earth's gravity). For the given class, a standardized procedure is defined, on which the *fundamental* measurement of a given property relies.[11] The result of a measurement indicates the equivalence class to which the measured world-state belongs. For this purpose, a suitable physical manipulation / transformation of the world-state is needed; starting from a reference or 'zero'-state, the number of iterations until the equivalence with the measured state is reached serves as the index.[12]

Fundamental measurements thus contain a *production rule*, a preparation of a world-state matching another state or identified by a numerical index. The production rule is necessarily of physical character (*e. g.* adding weights to a balance pan); the only place for subjective sensation is recognition of equivalence (*e. g.* a coïncidence of the balance pointer with the zero mark). Especially, controlled variation of the stimulus configuration (world-state presented to S) is the function of experimental construction; this is why the stimulation apparatus has to be *calibrated*.

Example: Order of brightness

In an experiment in perception, the apparatus is a part of the world shared by E and S, a physical system which can attain different configurations. 'Preparation of stimuli' involves variation of the apparatus; the focus on a certain aspect of perception determines the dimension w. r. t. which equivalences are defined, and along which equivalent configurations are being ordered.

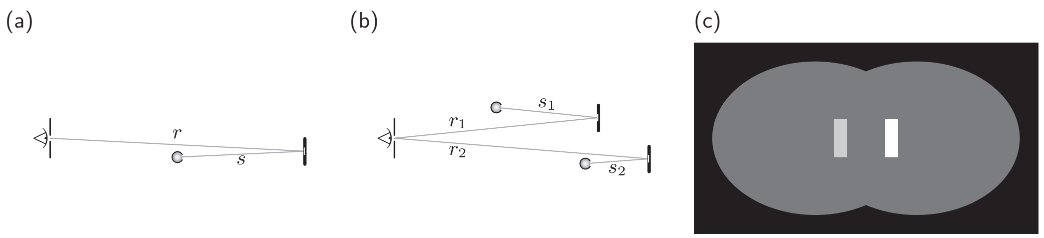

Figure 1. a: Luminous spot display. b: Configuration of two spot displays. c: Subject's view.

Consider, for illustration, a system consisting of a standard light source and a diffusive-reflective spot on a dark surface orthogonal to the axis of view (Fig. 1a). This is a simple stimulation device with two degrees of freedom: varying the source–reflector distance s and the reflector–eye distance r, we have different percepts in terms of perceived brightness.[13] Combining two such systems in the visual field (Fig. 1b), we construct an apparatus with $2+2$ = 4 d.f. Varying the configurations (s_1, r_1, s_2, r_2), we find that equivalences produced by the 'equal brightness' instruction form 3-dimensional manifolds that can be linearly ordered along a single dimension ($4-3$ = 1).

Equipped with this construction and a method of length measurement, we may arrive at an elementary law of optics—the inverse square law. Knowledge of this law allows to measure luminosities of light sources *via* distance measurements; or inversely, to measure distances *via* apparent brightness of standard sources. In either case, visual sensation serves only to determine the equivalence: in these experiments we never refer to 'brightness' as a *quale*, to 'what is it like to have a luminous sensation'.[14] S's subjective experience of 'brightness' plays solely indexical rôle.

We may use the same construction to measure S's differential thresholds for perceived brightness, now manipulating distances of standard light spots to vary their appearance. This would generally result in a system of equivalences separated by 'just noticeable difference'. But here again the results are specified are physical measures, specifying configurations of the apparatus as adjusted by properly instructed subject. — Physics of light and (psycho)physics of sight can be studied principally with the same apparatus. It is not the locus of measurement but merely the focus of interest (instruction) what differentiates between the two types of experiments.

Summary

The proper locus of measurement is *always* the world 'out there', whatever the focus of interest. In this sense Mach's observation was correct: what was originally thought of as 'measurement of the mental', eventually turns out to be a measure of the physical. But we must add that 'physical' here refers to the world of tangible and manipulable things given in inter-subjectively communicable experience—not to the abstractly 'objective' physical entities (theoretical constructs).

Psychophysical experiments are artificial perceptual situations, which are co-arranged by E and S within a shared sector of the world. Measurements are performed on the apparatus, *i. e.*, in the world, not in S's mind. The functional relations, or 'laws', discovered in this way refer to possible states of the entire experimental arrangement, under constraints imposed by the instruction. Since we have abandoned 'sensation' as a mental entity, and rejected the identification of sensation with a neural state, the notion of 'sensations measurement' turns out to be meaningless: there is nothing to be measured 'in the subject's mind'. What, then, is the aim and task of psychophysics? The line of thought followed in the preceding sections leads to the following interpretation: *psychophysics is a physics of the world inhabitated by sentient and sensible subjects.*

Notes

1 A revised version of a paper presented at a joint workshop 'Taking Perspectives in Sciences' of the Centre for Theoretical Study (Prague) and the Institute for Frontier Areas of Psychology, held in Freiburg, April 5–6, 2008. Thanks to Carsten Allefeld for helpful comments on an earlier draft of the paper.

2 *Cf.* Fechner's summary [4] on the issue of 'mental measurement'; for a review of critical discussions of this problematic notion, see Heidelberger [7, pp. 207ff].

3 In German original: "Wenn es Fechner in seiner Psychophysik gelungen ist, selbst die einzelnen Empfindungen zu messen, so kann man doch über die Bedeutung dieses Masses zweifelhaft sein. Eine Empfindung von grösserer Intensität ist immer auch eine von anderer Qualität und das Fechner'sche Mass ist dann wohl mehr ein physikalisches als ein psychisches." — These words are part of a final general remark [*Allgemeine Bemerkung*], where Mach defines the aims and scopes of three major scientific disciplines, namely physics, psychology, and psychophysics.

4 In Austin's words, this is "a typically scholastic view attributable, first, to an obsession with a few particular words ... and second, to an obsession with a few half-studied 'facts' " [1, p. 3]. As for the latter, Austin explicitly warns against "such illusions as 'the argument from illusion' " [p. 4].

5 This should not be misunderstood as a brute eliminativism: "sensation is no-thing" says that 'there is no thing-like entity called 'sensation'. Of course, we do not deny that we are beings capable of sensing and feeling; the term 'sensation' stays reserved for the act of sensing.

6 In a discussion following the presentation of [12] the following remark was dropped: "I was told twenty years ago that psychophysics was about measurement of sensations, and this is what I still do. Do you want to tell me that all this was done in error?"

7 "[T]he input to a sensory system is the physical stimulus and the output is sensation ... if the device were a photo cell ... we would measure the output in voltage or current as a function of energy input." [6, p. 183] — This simile may apply to sensory systems as transducers of physical quantities, where *e. g.* energy density of the stimulus is the input and cell membrane potential or neuronal firing rate is the output. But then the functional relations obtained in this way belong *entirely to the physical domain*; it is unclear how the output of any neural or physical subsystem can be termed 'sensation'.

8 Feigl coined the terms 'egocentric' and 'lateral perspective', respectively, for the 1st and 3rd person's view of the causal chain [5, p. 84].

9 Mentioned already by Bridgman [2, p. 30f] among some other amusing, seemingly "deep" questions.

10 Properties of physical reality are not given *a priori*; they are found in the course of inventions of material or symbolic transformations of world-states. The operations involved are contained in definitions of physical quantities [2].

[11] Practical measurements are mostly of *derived* nature, involving some mediating steps from the really observed phenomenon to the fundamental definition. For example, we can measure intensity of electric current *via* dilatation of a wire due to thermic effects of the current passing through the wire.
[12] This ascertains a minimal arithmetic structure in the domain of measurement results. The refinement from integer indeces to the field of rationals is the subject of a standard theory (Helmholtz–Hölder).
[13] We assume for simplicity that angular deviations of light rays deviate only minimally from the view axis, and that the reflection characteristic is uniform within that range.
[14] Psychophysics neither supports nor requires a realism of *qualia* and is, in fact, indifferent to this problem; *cf*. note 5.

References

[1] J. L. Austin, *Sense and Sensibilia*. Oxford: Clarendon Press, 1962.

[2] P. W. Bridgman, *The Logic of Modern Physics*. New York: MacMillan, 1927.

[3] G. [Th.] Fechner, *Elements of Psychophysics*. New York: Holt, 1966.

[4] G. Th. Fechner, 'My own viewpoint on mental measurement (1887).' *Psychological Research* **49**: 213–219, 1987. [Translated and edited by E. Scheerer.]

[5] H. Feigl, *The 'Mental' and the 'Physical'. The Essay and a Postscript*. University of Minnesota Press, 1967.

[6] G. A. Gescheider, *Psychophysics: The Fundamentals*. 3rd ed. Mahwah: Lawrence Erlbaum, 1997.

[7] M. Heidelberger, *Nature from Within. Gustav Theodor Fechner and His Psychophysical Worldview*. University of Pittsburgh Press, 2004.

[8] M. W. Levine, *Fundamentals of Sensation and Perception* 3rd ed. Oxford: University Press, 2000.

[9] E. Mach, *Die Geschichte und die Wurzel des Satzes von der Erhaltung der Arbeit*. Prague: Calve, 1872. [Reprinted in J. Thiele's edition, Amsterdam: Bonset, 1969.]

[10] G. Ryle, *The Concept of Mind*. Hutchinson, 1949.

[11] H. R. Schiffman, *Sensation and Perception. An Integrated Approach*. 2nd ed. New York: Wiley, 1982.

[12] J. Wackermann, 'Psychophysics, or algebra of primary experience?' In *Fechner Day 2007*, ed. by S. Mori, T. Miyaoka and W. Wong, Tokyo: International Society for Psychophysics, pp. 51–56.

HEDONIC ASSIMILATION WITH SIMULTANEOUS PRESENTATION

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Abstract

A target painting was rated as less hedonically positive when simultaneously presented with hedonically negative context paintings and subjects were given instructions to view the paintings as a group than when the target was viewed alone (i.e., assimilation occurred). This is unlike what happens with sequential presentation which produces hedonic contrast. The hedonic assimilation was not diminished by having subjects compare the context and target stimuli, contrary to the ideas of Stapel and colleagues.

Judgments of stimuli change with changes in context stimuli. The effect of the context stimuli on the test stimuli can take two different forms. Some studies show contrast -- judgment of the test stimuli moving in the direction away from the context stimuli. Other studies show assimilation -- judgment of the test stimuli moving toward the context stimuli. In our studies of context effects on hedonic judgments we have always found contrast rather than assimilation. That is, the test stimuli are rated as less "good" following very good context stimuli than when presented alone (Rota & Zellner, 2007; Zellner, Rohm, Bassetti, & Parker, 2003) or the test stimuli are rated as "better" following very bad context stimuli than when presented alone (Dolese, Zellner, Vasserman, & Parker, 2005).

However, other studies in which subjects have judged things as varied as the attractiveness of people and the length of lines have found both assimilation (attractiveness – Geiselman, Haight, & Kimata, 1984; line length – Brigell & Uhlarik, 1979; Jordan & Uhlarik, 1985) and contrast effects (attractiveness – Kenrick & Gutierres, 1980; line length – Brigell & Uhlarik, 1979; Jordan & Uhlarik, 1985) in judgments. One factor that seems to be important in determining whether assimilation or contrast will occur is whether the test stimuli are presented at the same time as the context stimuli (simultaneous presentation) or if the test stimuli are presented after presentation of the context stimuli (sequential presentation) (Wedell, Parducci, & Geiselman, 1987). The differences in effects of context stimuli on test stimuli in the two types of presentations has been proposed to be the result of perceiving the test and context stimuli as a unit or a Gestalt when presented simultaneously and as separate items when presented sequentially (Girgus & Coren, 1982; King, 2001).

In addition to the timing of presentation of the stimuli, the way in which the information about the context stimuli is used in the judgment of the test stimuli can also influence whether hedonic contrast or assimilation occurs. If subjects compare the test stimuli to the context stimuli there is likely to be contrast. However, if the context stimuli are used to interpret the test stimuli, assimilation is more likely to occur (Stapel & Koomen, 2001; Stapel, Koomen & van der Plight, 1997; Stapel & Winkielman, 1998).

We always presented the stimuli sequentially in our studies of hedonic context effects and always found hedonic contrast. We suspect that if we presented the context and test stimuli simultaneously we would be more likely to see assimilation. In addition, according to Wanke, Bless, and Igou (2001), this assimilation should be reduced by priming subjects to compare the test stimuli with the context stimuli rather than seeing the test stimulus as one of a group with the context stimuli; they believe that the assimilative effect of the simultaneous presentation and the contrastive effect of comparison judgments should be additive.