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THE CLASSICAL PSYCHOLOGISTS

THE CLASSICAL PSYCHOLOGISTS

SELECTIONS
ILLUSTRATING PSYCHOLOGY
FROM ANAXAGORAS TO WUNDT

COMPILED BY
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BOSTON NEW YORK CHICAGO
HOUGHTON MIFFLIN COMPANY
The Riverside Press Cambridge

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PREFACE

"THE CLASSICAL PSYCHOLOGISTS" is a companion volume in the field of psychology to the author's "The Classical Moralists" in the sphere of ethics, and also to his "Modern Classical Philosophers" in the domain of philosophy. Its aim is to present in a series of selections some of the most essential features of the psychological doctrines which have appeared from Anaxagoras to Wundt. The book is thus virtually a history of psychology, not derived from an ordinary description of systems, but based upon extracts from original sources and upon translations of the authors themselves. Such a work, it is hoped, may prove adapted for colleges and universities as a text-book of reading accompanying courses of lectures in general psychology, and may become a necessary requirement of study made of all students before entering upon the study of the special divisions of existing psychology. The general reader, moreover, will find it an interesting volume of original material of the great psychologists from the earliest to the most recent times.

From Aristotle's "De Anima" there is reproduced at the outset the first extant history of psychological theories. With the name of Anaxagoras, who emphasizes the *Nous* as present in all things, but with insight as to its different forms in mind and matter, it was thought the work might fittingly begin. Empedocles is mentioned, who maintains that like is known by like, and that perception is due to elements in us coming in contact with similar elements outside. Democritus is also included, who believes the soul to consist of atoms, the peculiar fineness, smoothness, and mobility of which cause perception and thought. The second selection is taken from the *Theaetetus* of Plato, which Professor Jowett describes as the oldest work in psychology that has come down to us, and which here contains the contending Sophistic and Socratic views on the nature

of perception. In it Protagoras affirms that the individual man is the measure of all things, whereas Socrates seeks to conduct Theaetetus by means of the dialogue to the acceptance of a universally valid knowledge. Although Plato's psychological views are scattered through various dialogues, the Republic best contains his treatment of the fundamental problem of the relation of soul and body. There is consequently printed from it, his presentation of the three faculties of the soul, of the correlation of the faculties, and of the soul's immortality. In Aristotle we have the greatest psychologist of the ancient world, and the one who first treated psychology as a separate science. To the introductory account of earlier theories by him, with which this work began, is here added a description from the "De Anima" of his own doctrines. His conceptions of the essence of the soul, and its relation to the body as form to matter, of the various activities of the five senses and the common sense, and of the functions of sensation, imagination, and thought, are given in full, as their importance demands. From Diogenes Laertius' "Lives and Opinions of Eminent Philosophers" is drawn the psychology of the Stoics, in which the animating principle of the soul is described as a warm breath within us, with a resultant trichotomy of body, soul and spirit. From Diogenes Laertius is likewise taken the Epicurean psychology, in which the soul is conceived to be a bodily substance composed of exceedingly fine atoms, which are allied in nature to air and fire, and are diffused throughout the whole body. Lucretius in the didactic poem on "The Nature of Things," whereby Hellenistic thought was transferred to Rome, follows next with a description, like that of Epicurus, of sensation as everywhere occurring in the body; but he regards the mind as the directing principle "holding the fastnesses of life." From the "Enneades" of Plotinus, who was the most eminent of the Neoplatonists, is reproduced the theory of emanation, in which the soul is deemed the image and product of the Nous, just as the Nous is of the One.

In the mediæval period, Tertullian, one of the greatest of the early Christian fathers, sets forth in the extracts presented from

his "Treatise on the Soul," the corporeal nature of the soul, its simplicity, its source in the breath of God, its rationality, and its immortality. Gregory of Nyssa, who wrote in the latter part of the fourth century, here argues in the "Endowment of Man," that the intellect pervades all parts of the body alike, but has in itself a divine beauty, since it is created in the image of the most beautiful. Augustine, in whom the Patristic period reached its culmination, emphasizes in his work "On the Trinity," self-consciousness as the distinguishing characteristic of the mind arising from its immateriality, and regards memory, understanding, and particularly will, as its most important faculties. Thomas Aquinas, who represents scholasticism in its full development, returns in the "Summa Theologica" to the Aristotelian doctrine of the rational soul as the essential form of the body, and contends as against Augustine for the superiority of reason to will.

The modern period is introduced with chapters from Thomas Hobbes' "Human Nature," in which the founder of empirical psychology reduces all mental processes to motions. An ample presentation is given of Descartes' "The Passions of the Soul," of which Professor David Irons says that "it would be difficult indeed to find any treatment of the emotions much superior to it in originality, thoroughness, and suggestiveness." Spinoza, who teaches in "The Ethics" that the soul and body are not two distinct substances, but that thought and extension are two of the many attributes of the one real being, seeks to prove by the mathematical method in the part reproduced, that the order and connection of ideas are identical with the order and connection of things. From Leibnitz' "Philosophical Works" selections have been made in which he presents his theory of monads, and likewise illustrates the interaction of soul and body after the manner of two clocks so constructed as to run in perfect harmony. Christian Wolff, whose name is chiefly associated with the faculty psychology, designates in those sections of the "Rational Psychology" here chosen, the *vis repræsentiva* as the fundamental force and sufficient ground for everything that takes place in the soul.

English empirical psychology is next traced through Locke, Berkeley, and Hume. From Locke's "Essay on the Human Understanding" there is given, as Locke believes, "the true history of the beginning of human knowledge," wherein all our ideas are derived from sensation and reflection. Berkeley's "Essay towards a new Theory of Vision" is reproduced with desirable fullness, as it contains his noted research into the difference between the ideas of sight and touch, wherein he draws the striking inference that the visible world is a visible language, which we learn to translate into the tactual experience that the visible phenomena naturally signify. Hume in the chapters from the "Treatise of Human Nature" would resolve all perceptions of the human mind into "impressions" and "ideas," differing only in force and liveliness, and also would derive our conception of necessary connection solely from the experience of the constant association of certain objects. Hartley was the chief precursor of English associational psychology, although preceded as he confesses by the modest Gay, and from the "Observations on Man" are reprinted his two principal doctrines of *vibrations*, and of *association*.

Charles Bonnet, the Swiss, and an early founder of physiological psychology, in the "Analytical Essay upon the Faculties of the Soul" of which his own "Abstract" has been in part translated, lays stress throughout on the dependence of psychical phenomena upon physical conditions, and considers the diversity of mental perceptions as really due to the different structures of the various sensory fibres. The French psychologist Condillac, in the chapters from the "Treatise of Sensations," views all psychical functions as transformations of sensations, and graphically illustrates his theory by the endowment of a marble statue with the different senses of man in succession. From Reid, founder of the Scotch School of common sense, those portions of the "Essays on the Intellectual Powers of Man" are given in which he analyzes the fundamental acts of sensation and perception, contending that the former is confined to the soul, but that the latter implies a belief in the existence of an external world. Brown's eloquent "Lectures on the Philo-

sophy of the Human Mind," published after his death, contains a most subtle and brilliant analysis of muscular sensations, the inclusion of which, it is believed, must add substantial value to the pages of this work.

With Herbart's "Textbook of Psychology" begins scientific psychological research, in which from the intensive relations of ideas and the laws of their change it is sought to derive the possibility and necessity of applying mathematics to psychology. In Beneke's "Textbook of Psychology as Natural Science" a profound German psychologist seeks to reduce all psychical phenomena to four "fundamental processes." Drobisch, who may be regarded as one of the distinguished representatives of mathematical psychology, presents in his "Empirical Psychology," the dynamics of ideas as the fundamental principle of explanation of psychical phenomena. Maine de Biran, whom Cousin thought the first metaphysician of the nineteenth century, has written some most instructive chapters in his "Essay upon the Foundations of Psychology," wherein he treats of voluntary effort as the primordial fact of our psychical life, analyzing it into the two distinct but inseparable elements of will and resistance of our own body, from which he derives the beginning of personality.

The revival of English associational psychology is to be found in the chapters taken from James Mill's "Analysis of the Phenomena of the Human Mind"; but its fullest fruition appears in the laws of association reproduced at considerable length from Bain's "The Senses and the Intellect." The cardinal feature of Spencer's "Principles of Psychology" is here presented in the evolution of mind "from an indefinite incoherent homogeneity to a definite coherent heterogeneity." The selection from Johannes Mueller's "Elements of Physiology" will render more accessible his very important account of the general laws of sensation. A fitting place is naturally given also to Lotze's theory of "local signs" as embodied in his "Outlines of Psychology."

In more recent psychology, translations from Weber's "The Sense of Touch and the Common Feeling" of his well known

Law, and from Fechner's "Elements of Psychophysics" of his "Measurement of Sensation," are indispensable contributions in the domain of psychophysics, being the experiments of the former, well described by Professor E. B. Titchener, as "the foundation stone of experimental psychology," and the interpretation of the latter as the erection in large measure of "a whole building." The Young-Helmholtz theory of color vision has been translated from Helmholtz's "Manual of Physiological Optics," which is regarded as the most important work that has yet appeared on the physiology and physics of vision. "The Fundamental Principles of a Theory of Light Sensation" by Hering will serve also to supplement those of Helmholtz, as a necessary foundation for the study of the more recent valuable contributions which have been made to this subject. From Mach's "Analysis of Sensations" is reproduced his theory of space perception, preceded by an account of the self intuition of the ego, which "every student of psychology should know." Stumpf's "Tone Psychology" contains a theory of tonal fusion, written by a recognised authority in this domain. The remarkable chapter of William James entitled "The Stream of Consciousness" is taken from his introductory "Psychology." Then follows the James-Lange theory of emotions, in which a novel doctrine is set forth by both writers with unusual brilliancy of style. Most characteristic and authoritative chapters from Wundt's "Principles of Physiological Psychology" on the problem of physiological psychology, and from his "Outlines of Psychology" on volition and apperception, conclude the work.

The outline of the selections in the preceding paragraphs traces the attempt, here made for the first time, to present historically in a single volume original texts containing fundamental theories of the classical psychologists, alike in ancient, mediaeval, and modern times. The study of psychology as pursued to-day in several important divisions might suggest the desirability of a work of recent material from these various domains. An historical volume of the character of this book was, however, deemed not only more in harmony with the other works of the author's series, but also as much more necessary for the

use of students before entering upon investigations in special fields. Whilst a chronological order has been followed in general, slight variations have made it possible to group psychologists somewhat according to their schools, and the emphasis, moreover, in the most recent period, has been placed on the selection of those important laws and theories which have already taken on a classical importance. The selections have been given with sufficient fullness, it is hoped, always to reproduce the author and subject in an intelligible and connected way. Authorities will differ concerning the choice of authors and subjects. In this matter important advice has been received from the psychologists alike of Harvard University and also of other large American Universities. Although such valuable opinion always has been carefully considered, the responsibility for the final decision naturally rests upon the editor.

Thirteen authors appear in this work in selections translated for the first time into English. To my colleague Professor Edward Kennard Rand, of the classical department of Harvard University, I am indebted for the translation from the Latin of "The essence and nature of the soul" contained in Christian Wolff's "Rational Psychology"; and to Dr. Herbert Sidney Langfeld of the Harvard Psychological Department for the translation from the German of "The measurement of sensation" in Gustav Fechner's "Elements of Psychophysics." The translations from the Greek of Gregory of Nyssa, from the Latin of Thomas Aquinas, from the French of Charles Bonnet and Maine de Biran, and from the German of Friedrich Eduard Beneke, Moritz Wilhelm Drobisch, Ernst Heinrich Weber, Heinrich von Helmholtz, Ewald Hering, Carl Stumpf, and Carl Lange in the text of H. Kurella, have been made by the author of this work. In French Professor Irving Babbitt and Dr. C. J. Ducasse, and in German Prof. W. G. Howard and Dr. J. Loewenberg of Harvard have made valuable suggestions. My thanks for permission to reprint selections of various psychologists are also due to the publishers and translators whose names will be found at the beginning of the respective chapters accompanying the titles of the works thus utilized. The book

will best attain its desired aims if its representative selections shall serve to inspire the perusal of the complete works of the classical psychologists, and if it shall aid in any measure to maintain the importance and prestige of classical psychology.

BENJAMIN RAND.

EMERSON HALL, HARVARD UNIVERSITY.

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XLIII. WILHELM WUNDT (1832-)

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CARL STUMPF

(1848-)

THE PSYCHOLOGY OF TONE

Translated from the German by*

BENJAMIN RAND

§ 19. THE DEGREES OF TONAL FUSION

1. *What tonal fusion is and what it is not.*

It has already been mentioned in what precedes, that not merely do simultaneous as contrasted with successive tones enter into a special relation in sensation, which renders their analysis difficult, but that also there are differences in this respect among simultaneous tones, according to the numerical ratio of their vibrations. We must now turn our attention to this fact. I will first illustrate it by two extreme examples.

If two tones, the number of whose vibrations are related as 1:2, are simultaneously produced, they can be very imperfectly discriminated in comparison with the case where, for example, under otherwise precisely similar conditions, the ratio is as 40:77. When I say, "imperfectly," I mean that the question is not as to a difficulty, which might be overcome by increased attention and practise, but as to an unchangeable characteristic of the material of sensation, which persists even after all other obstacles to an analysis have been removed, and which, moreover, after the analysis is completed and the tones clearly recognized as two, can first likewise be perceived in itself. In 40:77 the tones in the sensation appear so to speak farther apart than in the case of 1:2, so that in the first case even the unmusical person is less, or not at all, in danger of taking them for one; whereas on the contrary, the octave tones cannot be kept distinct even by the

* From C. Stumpf's *Tonpsychologie*, Leipzig, 1890, Bd. II.

most delicate and practised ear, in the same degree as those of the seventh, or of the unmusical relation 40:77. When the unpractised designate simultaneous octave tones as one tone, there is accordingly a double hindrance to analysis, namely: one an imperfect practise, and the other in the tone itself; one, which influences the judgment directly, and the other which influences the sensation and in consequence of it the judgment.

What is most essential for the general characterisation of the concept of *fusion*, as we understand it, has been fairly exhausted in what has been said,¹ and can be set forth still more clearly only in the more inclusive range of a universal theory of relations, which is one of the most urgent needs of philosophical science. We term fusion that relation of two contents, especially sensation-contents, in which they form not a mere sum, but a whole. The consequence of this relation is, that in its higher degrees the total impression under otherwise like conditions approaches more and more that of a single unified sensation, and becomes more and more difficult to analyze. These results can also be employed for a definition, and we can say: fusion is that relation of two sensations as a consequence of which, etc. But in either way, the matter would remain an empty concept for everyone to whom the phenomena in question, and especially the phenomena of tones, were foreign. The real truth of the assertion, that sensations form a whole and approximate more or less the impression of a single unified sensation, can after all be learned only by means of examples.

Nevertheless, I remark, that the inclusion of the concept of tonal fusion under that more general quality of simultaneous as opposed to successive sensations, of which we have elsewhere spoken, is not indispensable for what follows. The tonal fusion will acquire for us more and more an interest of its own, independent of the questions previously discussed (§ 16 and 17); and would also claim it even if a similar relation did not further occur in the entire domain of sensations. It is far from being an hypothesis devised for the solution of those difficulties. It is a sensuous phenomena which was observed even before those

¹ Cf. Stumpf's *Tonpsychologie*, p. 64 f.

theoretical difficulties appeared within the intellectual horizon. It suffices perfectly for the attainment of the concept here necessary, to perceive and in perceiving to contrast, the differences of the cases which exist already within the tonal domain, and which will be more accurately described in what follows. We must hear and compare tonal fusions, just as we must hear and contrast tones, in order to know what a tone is.

Perhaps, however, it is expedient to preclude expressly some misconceptions which the term *fusion* might occasion. It is precisely one of those psychological expressions which have been most misused, and to which the most impossible conceptions and entirely fictitious theories have become attached. For this reason I have chosen it with reluctance, owing to the lack of a safer and at the same time more specific word.

It is above all, therefore, not meant by fusion, that two simultaneous tones coalesce in a certain unity in consciousness only by degrees, however quickly. Fusion signifies to us here not a process, but a present relation. I would, therefore, rather use "blend" (*Schmelz*), or "coalescence" (*Schmalz*), if this had also not its objections. Such expressions also as "to separate" (*auseinandertreten*) etc., are to be understood in this sense of an already existent being; just as they are likewise used in the sense of rest in the description of architectonic forms.

That fusion is not to be viewed as originating a third tonal quality in addition to or instead of the other two, needs no farther amplification after what has preceded (§ 16 and 17).

Henceforth we must reject especially the metaphorical use of spatial concepts. The naturalist is accustomed to think of everything by the aid of spatial analogies; and psychologists also, like Herbart and Beneke, who desire to approach the exactness of natural science, employ them most extensively for their psychological descriptions (such as, falling and rising, overflowing, etc.). We are to disregard all such analogies as might erroneously suggest them. Everything extended in space is either outside, or identical with everything else. But simultaneous tones afford us an example of interpenetration; and, indeed, an interpenetration of a lower and higher degree. The

lack of all spatial perceptibility is wholly immaterial. It is, however, wanting in the relation of quality and intensity. Spatial perceptivity ceases moreover with psychical states as such (cf. § 100-104). The concepts here too must be adapted to the observations. Only a contradiction is *a priori* an impossibility. But that the two tones are at the same time one, is not affirmed.

In general the difficulties, which one still could, and will find, in the concept of tonal fusion, as it is here understood, are bound to be of a similar kind and origin to those raised from time immemorial against the concept of motion. And as the physicist gets rid of these after the example of Diogenes, who stepping from his tub walked about with a "solvitur ambulando," so here in a similar manner the first thing we have to do is to oppose to all reasoning a "solvitur audiendo." But then here as there, it becomes evident that the difficulties are avoided, the moment that the mixture of heterogeneous concepts is avoided.

Finally it is to be remarked, that the expression and concept of fusion stands here in no relation, either essentially or historically, with the general psychological doctrine of Herbart, in which "fusion" plays such a prominent part; and which for the sake of clearness everyone, who has knowledge of it, is asked for the present to banish from his mind. In a subsequent chapter, where the cause and origin of fusion are treated, we will attempt to show how far Herbart's theory of fusion in general, and of tonal fusion in particular, is from being correct.

Our conception of fusion has also not many points of contact with the ideas which have been brought forward under the same name oftentimes in the most recent psychology, and in my judgment on every occasion is in contradiction with the truth.

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2. *The Degrees of Fusion*

If in the first place we confine ourselves to a tonal domain, which is limited by the ratio of vibrations 1:2, I remark the

following degrees of different tones, from the highest to the lowest.

First the fusion of the octave (1:2).

Secondly that of the fifth (2:3).

Thirdly that of the fourth (3:4).

Fourthly that of the so-called natural thirds and sixths (4:5, 5:6, 3:5, 5:8), between which I find in this respect no clear distinctions.

Fifthly that of all the remaining musical and unmusical tonal combinations, which, for my hearing at least, offer no discernible differences of fusion, but on the contrary all the least degree of it. At most the so-called natural seventh (4:7) could indeed fuse somewhat more than the others.

If we employ here the modern names of the intervals, and the general expression *interval* itself, we do so not in any musical sense at all, but only to have a known and short term for the numerical relations of vibrations with which we are here concerned.

When we speak of *degrees* of fusion, we mean that we are dealing with the degrees of differences, which, as is well known, constantly pass over into one another, from the highest to the lowest degree. Further we make use also of the general expression *degrees of fusion*.

3. *The Laws of Fusion*

The dependence of the degrees of fusion upon the so-called ratio of vibrations is the principal law of tonal fusion. In addition to it stand the following:

(a) The degree of fusion is independent of the tonal region. In the lowest pitch, where analysis meets with difficulties, the recognition and comparison of degrees of fusion become naturally difficult and impossible. But where it is possible, we find the fusion unchanged with the change of pitch, so long only as the ratio of vibrations of the two tones remain the same.

Only in the very highest pitch, approximating about 4000 vibrations, that is, from the octave five tones above the staff upward, do the differences of fusion appear to me, so far as I have

yet been able to observe, to vanish. With tuning-forks 2000:3000 I still discern with full clearness the fusion of the fifth, whereas with 3000:5000, 5000:10000, etc., I can discern only the slightest degree of fusion at all.

(*b*) The degree of fusion is also independent of the strength, whether indeed it be the absolute or the relative strength. That it is not changed by the mere change of the absolute strength of the two tones is at once clear. With the change of relative strength it is again noteworthy, that ultimately analysis becomes impossible with great difference of strength, since the softer is suppressed by the stronger tone, so far as perception or even sensation is concerned. But so long as they remain distinguishable, I cannot notice any change of the degree of fusion. For example, if I make *c* and *g* at first of equal strength, then *c* noticeably stronger than *g*, or the reverse.

(*c*) The degree of fusion of two given tones is in no way influenced by the addition at pleasure of a third and fourth tone. Indeed, a consonance is so much the less easily analyzed, the more tones it contains, and becomes at last wholly confused and not analysable. But so long as two tones are at all distinguishable in a composite sound, their fusion also is recognised as the same as if the two alone were sounded.

In this proposition together with (*b*), there is also expressed the fact, that the overtones especially, and thereby the timbre, make no change in the ratio of two fundamental tones of musical sounds, as is also confirmed by direct observation.

(*d*) As in general the changes of stimulus below a certain degree effect no perceptible changes of sensation, so likewise very minute deviations of the number of vibrations from the above-mentioned ratios create no perceptible change of the degree of fusion. If the deviation is increased, the fusion in all pairs of tones which do not belong to the very lowest degree of fusion, passes into this degree without running through the intermediate degrees, if any. And this transition occurs the more rapidly, (with the smaller relative differences of vibrations), the greater was the initial fusion.

We say, as is known in the case of small but perceptible deviations, that the interval is "out of tune" or "impure." This saying possesses, as we may remark by anticipation, not merely a reference to the disagreeable feeling which is only a consequence of perception, but above all to an actual and perceived behavior of sensations.

With regard to the size of the deviation in which the change of the degree of fusion is discernible, practise besides other circumstances (e.g., pitch) makes a difference. But this forms no objection to the definition of the degree of fusion as a fact of sensation. As a sensation itself can change, so also can the ratio of two sensations, without the change being remarked; and this can be imperceptible to another through the equality of sensations, (not merely of stimuli).

(e) The fusion remains and retains its degree when both tones do not affect the same ear, but one is presented exclusively to the right, the other exclusively to the left. A tuning-fork of medium pitch, that is not sounded too loud, held before one ear is not perceived by the other, as we discover from the fact, that if the first is stopped up nothing is heard. If now we apply two forks which for example form a fifth, one to each ear, no difference is observable between this fusion, and the perception by one and the same ear. On the contrary, the analysis can be facilitated by this process (cf § 23, 1 and 24. a).

(f) Fusion remains also in the mere representation of the imagination. If I merely represent c and g as sounding at the same time, I can conceive them only as fusing, and indeed with the definite degree of fusion which they possess in the actual hearing. The same is true of any other two tones. *A priori* this is not necessarily to be expected, even if we recognise sensations and representations of the imagination in general as similar. Not all properties of simultaneous sensations pass over of necessity to the representation of the imagination: c and c sharp in actual hearing (upon the same ear) necessarily make vibrations, but in the imagination I can represent them perfectly without vibrations. Moreover, if I represent them as vibrating, I can represent them with slow or quick, strong or weak vibra-

tions; whilst the choice of the degree of fusion is not free to me.

In regard to the representation of the imagination we must accordingly complete the fundamental law as follows: Tones represented as simultaneous fuse in the degree which corresponds to the ratio of vibration of tones of the same pitch created objectively.

(g) If we proceed above an octave, the same degrees of fusion recur with the rates of vibration increased one or more octaves. The ninths have the same fusion as the seconds, the tenths as the thirds, the double and triple octave as the octave; and in general $m:n.2^x$, the same as $m:n$, if $m < n$ and x a small whole number.

We must not be misled here by the greater ease of the analysis. C and c^4 sounding together are more easily and certainly analyzed by the unmusical than C and c , even than C and G ; although these two tones fuse less with one another than the former. The analysis depends upon very different conditions; it is peculiarly difficult especially in the lowest register; it is further facilitated by increase in the difference of pitch of the two tones. But if analysis takes place in both cases, we shall also further find, that C and c^4 are nevertheless in sensuous impression less perfectly sundered than C and G , and not more perfectly than C and c .

If I compare the sounds of the tuning-fork CG with Cg , CA with Ca , etc., it is evident to me, that detection of difference between every second combination is always easier, but the fusion is the same as in the first.

If I play upon the d^1 string of the violin the octave d^1 , and then the double octave d^2 (on the a^1 string), I have in both cases the same impression of homogeneity and of approximation to a real tonal unity. We can always for sake of contrast play the d in question with the free e^2 string; the difference of the fusion is always the same, that of the highest and of the lowest degree.

If an orchestra plays the entire 7 octave tones from C up to c^5 , we still designate the impression as *unison*. The seven tones

are more homogeneous than the two tones c and a , to say nothing of c and b . We cannot here assume as true, that only the two neighboring members of the series always fuse with one another, C with c , c with c^1 , etc., and that the farther removed do so only by means of the intermediate; for if C and c^5 fuse by themselves less than C and c , or even c and g , this could not be changed by means of the intervening octaves, according to (c).

Moreover, the special laws enunciated in the preceding principles can be directly observed in the enlarged intervals themselves. For example, this is true of that presented under (b), the recognition of which with many possibly meets with difficulties. Play upon the piano first c alone and observe the overtone g^1 (the twelfth), which we clearly hear sound at the same time, in respect to its fusion with the fundamental tone. Now add g^1 , by means of which this tone, too, becomes noticeably strengthened: the fusion with c remains unchanged. The fusion, therefore, in the intervals beyond the octave is independent also of the relation of strength.

4. *Rules of observation*

Those who are skilled in the judgment of tones can test, whether what precedes corresponds to their own perceptions. Where it is a question of relations which are based on the material of sensation itself, there is, indeed, no fear that very great individual differences will appear in those hearing normally. It is rather to be expected, that those capable of judgment will find among themselves more and more harmony, the longer and more carefully they examine. But I will not by any means claim to have found the correct solution in each of the mentioned points, and to have expressed it in an entirely correct manner.

It is necessary in these observations above everything to direct the attention exclusively upon the point in question, especially, therefore, to disregard theoretical knowledge of relationship, etc., as well as of the musical significance and position; and also to disregard the impression of feeling of an interval, whether it be harmonious or unharmonious, agreeable or dis-

agreeable, and furthermore in a different way agreeable or disagreeable. The character and value of the feeling of an interval depends, indeed, as we shall show later, upon its degree of fusion; but yet not solely upon this. The most agreeable interval is not one of strongest fusion. The great seventh is in isolated state more disagreeable than the small; and this cannot be mistaken for a lesser fusion, or explained by that. It has other grounds. The same is true of the great and small third, etc.

In general it will also be well first to take tones of the same sensation-strength, because then the danger is best avoided that any one of them should remain totally imperceptible or obscure. In order to produce similar strength of sensation in large intervals of tone, one must frequently — according to the instrument — give the higher tone with less physical strength. Further the greatest possible similarity in the initial utterance and duration of tone is naturally preferable, since inequalities of every kind divert the attention. Likewise, similar tone color is desirable, although this is of no influence in the fusion of the keynotes. Purity of interval, that is, exact harmony with the respective numbers of vibrations, is so much the more necessary, the more acute the hearing; although minimal variations, which can never be avoided, do no important injury to the fusion particularly in the lower grades. The piano with its tempered pitch permits the differences of the higher degrees still to appear (the octave is even here pure); but not between the last two degrees. It is even here $c:d$ sharp = $c:e$ flat, and $c:g$ sharp = $c:a$ flat.

But all these are measures of the kind that are matters of course for every observation. Nobody affirms that the phenomenon would be perceptible under only especially chosen circumstances. It is on the contrary in itself one of the most obvious, and so to speak most unavoidable, in the whole subject of unison. The entire task consists only in not confounding it with others which are based upon it, particularly with facts of judgment and of feeling (possibility and impossibility of analysis, pleasurable and displeasurable of an interval).

5. *Confirmation through unmusical persons*

For the guidance of my own judgment I have pursued still another method. As the question is here put, it can only be addressed to those who are sufficiently endowed with power of tonal observations to analyze the fifths and octaves easily and directly. With such there exists only the difficulty last mentioned, and many times previously touched upon, as to the dominating consciousness of the harmonious character and sensation-value of the interval. But we can obtain information also in an indirect way through unmusical persons, and those unpractised in the judgment of tones: by means of the use of the aforementioned difficulty of analysis. The different degrees of fusion must reveal themselves in the different degrees of difficulty of analysis, if all the remaining circumstances upon which the latter depend are taken precisely equal. We shall recognise them in the results. In this way we can even obtain figures, by the enumeration of correct and false judgments, upon the question, whether one or more tones are present in each interval. The combinations of more strongly fusing tones under otherwise similar conditions will more rarely be judged to be two tones than those fusing less strongly.

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§ 20. THE CAUSE OF TONAL FUSION

6. *The cause of fusion is physiological*

All the attempts at the explanation of tonal fusion previously considered have been psychological. Their failure signifies, that we can by no means seek the source of tonal fusion in the psychological domain. In favor of this view from the outset appeared to be the circumstance, that such tonal fusion is a fact of sensation, a relation immanent in simultaneous tonal qualities, and independent of practice in the individual life. But relations of sensation, like the sensations themselves, are not referable to more remote causes, but only to physical.

The physically objective characteristics of successive waves do not help us at all. To be sure, the total wave formed by two

waves in the ratio 1:2 is most similar to the simple sine-wave; then follows 2:3, 3:4, etc. more and more complicated forms. But these objective relations are, as was previously remarked, neither themselves the content of any sensation, nor the immediate cause of one; but on the contrary, they lie far back in the chain of causes. Moreover, if we consider it more closely from that standpoint, we find, that the so-called characteristic of the vibrations of the air disappear in the organ, if it is true here that every compound vibration is resolved into simple vibrations. Also as was previously mentioned, the circumstance that colors in which objectively the selfsame relations of vibrations occur, (1:2 in the extreme outer colors of the spectrum, 2:3 in blue and red, orange and indigo-violet, greenish-blue, and extreme red), reveal no phenomenon analogous to the tonal fusion, must prevent the objective forms of the waves from being made in any way responsible for the fusion.

That also within the organ, especially of the labyrinth in the ear, the physical processes do not yet possess that characteristic which corresponds to the fusion of the tones in sensation, appears not merely from the just-mentioned isolated transmission but also from the fact, that the fusion is perceptible in the same way when the two tones are divided between the two ears, as well as when they are merely imagined. At least it would be a violent and improbable assumption, that the process creating fusion in the case of simultaneous hearing occurs in the ear itself, but in the division of the tones occurs first in the brain.

Certain differences in the last processes of the centre of hearing must therefore correspond to the differences in the degrees of fusion as a physical correlate, or as a cause, (according as one thinks in a monistic or a dualistic way). But we know nothing of what nature these differences are, for this reason, if for no other, that in general we know nothing concerning the nature of the last processes. Indeed I must say, that although up to a certain point we can express in physical or chemical terms the occurrence of vibrations, competition, contrast, and other phenomena, in respect to the processes of the brain, which might lie at the basis of the phenomena of fusion, such a hypothetical

image does not even occur to me. Perhaps the practised fancy of certain mind readers will succeed better. But who knows, whether we shall not find ourselves gradually induced to recast or to extend our fundamental physical conceptions. Is it then *a priori* certain that the world beyond consciousness, (to which the brain indeed belongs), is spatial, and only spatial, or may be so conceived? Spatial properties are nothing but a small part of those which we abstract from our sense perceptions. We have found them serviceable for the rational construction of the external world, and for the derivation of its laws. But all other qualitative and remaining moments and relations of sensations have of themselves the same right to be transferred to the external world. And possibly fusion is itself destined sometime to participate in this dignity; perchance in application to chemical processes. But this is a mere play with the possibilities of thought, and we will not in place of physiological indulge in metaphysical fancies.

If we are willing in the lack of adequate apprehension to content ourselves with an abstract notion (which after all is nothing but a word), we might once more speak of specific energies. The specific energies, which lie at the foundation of fusion, have only this peculiarity, that they are not aroused by means of isolated stimuli, but by the concurrence of two stimuli. For this reason, we can call them specific energies of a higher rank, or still better, *specific synergies*. By such specific synergy we should therefore understand a determinate mode of coöperation of two nervous formations, having its ground in the structure of the brain, of such a kind that whenever these two formations produce their corresponding sensations, there arises at the same time a determinate degree of fusion of these sensations. As adequate and inadequate stimuli are distinguished in the production of sensations, by means of both of which nevertheless one and the same quality of sensation is produced; so likewise a determinate degree of fusion is here not united as such exclusively and unconditionally to the "adequate" stimulus-relation, (e.g., 1:2), but the same specific synergy can also, by way of exception, be aroused by another objective relation of

vibration, and the octave relation, etc., be established in the sensation. On the other hand, these specific energies of higher rank are, to be sure, inseparably united with those of the first rank: for the fusion reveals itself constantly as the same between two determinate qualities of tone.

That fusion remains preserved in imagination, is not opposed to what has been said, but is only a new example in proof of the fact, that the mere ideas of the imagination have themselves a physical basis, and indeed in general the same as the sensations.

In contrast to the theories of fusion already summarized, which give a very exact explanation concerning the process, our formulation must appear slight. But we would prefer honorable poverty to suspicious wealth, and remain mindful of the fact, that everywhere no other formulation than one in such general and abstract terms, is as yet certainly possible for the immediate and ultimate bases of our entire sensational life.

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