

Suppose we smoke the interior of our spectrophonic receiver, and fill the cavity with peroxide of nitrogen gas. We have then a combination that gives us good sounds in all parts of the spectrum (visible and invisible), except the ultra-violet. Now, pass a rapidly-interrupted beam of light through some substance whose absorption spectrum is to be investigated, and bands of sound and silence are observed upon exploring the spectrum, the silent positions corresponding to the absorption bands. Of course, the ear cannot for one moment compete with the eye in the examination of the visible part of the spectrum; but in the invisible part beyond the red, where the eye is useless, the ear is invaluable. In working in this region of the spectrum, lamp-black alone may be used in the spectrophonic receiver. Indeed, the sounds produced by this substance in the ultra-red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermo-pile. A few experiments that have been made may be interesting.

(1.) The interrupted beam was filtered through a saturated solution of alum.

Result: The range of audibility in the ultra-red was slightly reduced by the absorption of a narrow band of the rays of lowest refrangibility. The sounds in the visible part of the spectrum seemed to be unaffected.

(2.) A thin sheet of hard rubber was interposed in the path of the beam.

Result: Well-marked sounds in every part of the ultra-red. No sounds in the visible part of the spectrum, excepting the extreme half of the red.

These experiments reveal the cause of the curious fact alluded to in my paper read before the American Association last August—that sounds were heard from selenium when the beam was filtered through both hard rubber and alum at the same time. (See table of results in Fig. 14.)\*

(3.) A solution of ammonio-sulphate of copper was tried.

Result: When placed in the path of the beam the spectrum disappeared, with the exception of the blue and violet end. To the eye the spectrum was thus reduced to a single broad band of blue-violet light. To the ear, however, the spectrum revealed itself as two bands of sound with a broad space of silence between. The invisible rays transmitted constituted a narrow band just outside the red.

I think I have said enough to convince you of the value of this new method of examination, but I do not wish you to understand that we look upon our results as by any means complete. It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that our first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.

I recognize the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.

## CONTRIBUTIONS TO COMPARATIVE PSYCHOLOGY.

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### I. INSTINCT AND REASON.

In St. George Mivart's recent work, "The Cat," Chap. XI treats of the Psychology of that animal. Amidst the usual ambiguity to be found wherever such subjects are

treated, Mivart occasionally formulates his views. On page 369 his words admit of no other interpretation than an acknowledgement that instinct is nearly, though not quite pure automatism. The possession of reason by the cat is at first evasively dealt with, and finally on page 373, flatly denied. Mivart finds fault with Herbert Spencer's views as to instinct: "According to Mr. Spencer it is a higher development of reason which it has replaced, owing to the establishment of a more perfect adjustment of inner relations to outer relations than exists where mere reason is concerned." That opinion of Spencer's is one of the many which deserves to be rescued from the oblivion his involved style threatens to inflict upon the mass of his writings. From pure morphological and histological observations I have been led to the conclusions at which Spencer arrives by a wholly different route. The nervous system is a net-work of conducting substance interrelating the units of the animal body.

In an article by Spitzka ("Insane Delusions" page 34, *Journal Nervous and Mental Disease*, January, 1881), occur the following words: "In fact I should, if asked to point to the chief factor on which the higher powers of the human brain depend, lay less stress on the cortical development as such, than in the immense preponderance of the white substance due to the massive associating tracts."

Automaticity created by unvarying persistence of impressions resulting in certain definite movements, whether occurring through heredity, or during the lifetime of the individual (as proficiency in piano playing, etc.), has, for its material substratum, absolute definiteness of association of those parts which the nervous system connects; thus, regarded as a colony, the component individuals of the organism are brought into thorough automatic relationship with one another, and to that part of the environment to which the organism responds instinctively.

On the other hand reason is represented by the disconnected, shifting, short and long nerve fibres, as the arcuate of the cerebrum, not as yet assigned to any definite location. Reason thus is the struggle toward automatism. Instinct is the outcome of the struggle. Broadly viewing the higher nervous organization of animals there is a perpetual tendency to the establishment of nerve routes which would eventuate in handing over perfect control of every function to the highest nerve system. Spitzka expresses this (*Architecture of the Brain*, page 649 J. N. & M. D. Oct. 1879): "With the development of these highest projection fibres, the cerebral hemispheres gradually encroached on the independency of the lower ganglia, until in its maximal development as found in man, it resembles a great empire which holds a number of tributary states in sway under a common powerful rule. The automatical unity now attained, finds its parallel psychical culmination in that more perfect consciousness of the *ego*, which is peculiar to man." There is nothing debatable about this tendency on the part of the nervous system; the greater relative masses of the longitudinal and transverse associating tracts in the spinal cords, spinal and cerebro-spinal nerves and brains of all animals, in proportion to their reasoning and instinctive abilities, point to a prevailing law which seeks the reduction of all animal movements to the simplest mechanical methods. A corollary from instinct being perfected reason, would be that the salvation of reason to the race depended upon the vicissitudes and shifting circumstances with which we are surrounded, amounting to rescue from the fate mentioned by Wallace in degradation through parasitism. DeQuincey calls the human brain a palimpsest. In old age new tissues of any kind are formed with difficulty, new routes in the brain strive in vain for establishment; in senility the nervous tracts established in youth, and upon which all subsequent associations are founded, are the last to suffer disintegration, hence youthful recollections become at this time more vivid.

\*See page 250 for illustrations.