noted, have the plumose and curved forms occurring in the rosettes of the caverns mentioned.

GEORGE P. MERRILL.

THE NATURE OF THE SMILE AND LAUGH.

A DEFINITION of the smile and laugh is not needed by any one, for to every human being it is a self-evident birth-right, an axiomatic fact. Nor in general does this phenomenon (we shall consider in this essay the smile as only a lesser degree of the laugh) need description, and for the same reason. But the nature of the smile and laugh psychophysiologically does need explanation, why it is as it is and not otherwise. We shall try then here to look a little at the biological character of this incident of our common experience.

Herbert Spencer in his famous essay on 'The Physiology of Laughter' (1860), suggests as the occasions of the laugh, these: The ludicrous, joy, sardonic stimuli, hysterical states, mental distress, tickling, cold, and some acute pains. It seems, however, that pure or typical smiling and laughter comes from what is best termed joy, alone. It is only by inaccuracy of observation and a deficient consideration of certain facts that that smile-like expression of the face occasioned by 'sardonic stimuli,' mental distress, and acute pains is termed a smile, for while it is obvious, indeed, that the facial 'expression' of this tone of feeling is somewhat like that of unalloyed pleasantness, yet there are differences. These differences are chiefly in the mouth in the way of a greater uncovering of the upper teeth, with a different look about the eyes, the total appearance being harsher, in a way hard to particularize but very easy to feel. The so-called laughter of really painful states, at best only rarely observed, seems to depend on the well-established affective principle that the extremes of contraries tend to produce like effects, probably through the occurrence of wide radiation in the cortex, as would be expected when the stimulus is on the verge of abnormality of strength. Again, it must be remembered that so perfect and sensitive is the neuromuscular mechanism in question that even in an experience which is chiefly unpleasant or painful, even a momentary idea of any sort, or a brief cessation of the pain (in itself a pleasantness), would serve as the occasion of a true smile and so complicate the expression, giving it more the look of a properly occasioned smile. Tickling, on the other hand, is essentially pleasant if not too long continued; and it is characteristic of hysteria in a marked degree that it simulates arbitrarily every known emotion to perfection, or rather is in itself a versatile emotional state. It seems proper then to consider the laugh and smile as concomitant properly only to pleasantness or to pleasure, whether this affective tone be derived from purely conceptual relations, as in humor, or from stimulation of whatever bodily organs are in their action concomitant to pleasure.

One may observe even within the first week of the post-natal life of the infant that the eyes and especially the mouth display at times an incipient smile, the purely reflex or mechanical accompaniment of a true sensational pleasantness, arising usually from the normal functioning of the digestive process. A very few weeks later (two, as I have observed in one infant), the consciousness has become so far familiar, so to say, with its organism, as to bring out nearly if not quite in all its adult details the action of the inborn intricate mechanism of nerve and muscle. The 'hearty laugh' does not seem to occur until a somewhat later period, aloud and briefly perhaps by the end of the eighth week, but as a general bodily process not before two or three years of life have passed; this is not, probably, because of any incompleteness in the ap-

paratus of laughing, but because humor, which is the commonest occasion of this extreme manifestation, is not appreciated earlier. It seems probable that the shock produced by the sudden understanding of the 'point' of a joke has much to do with the intensity of the reaction in this case.

The practical perfection of the smile and laugh (as of the expression of grief and pain) at this very early period of life is a fact in itself worthy of note, and serves to emphasize both the universality of laughter in man and its deep-founding in the organism. When a few weeks old, or when even a few months old commonly, the average infant has not voluntary control enough over even its most mobile members, the finger and thumb, as to extend the latter into its mouth, even when the child searches his hand with his mouth with great eagerness for some much desired projection, and that even when it has been so extended for him repeatedly. The contrast of such helplessness with the innate perfection of the smile, involving the simultaneous action of a dozen or more muscles on each side of the face, is a striking illustration of innate reflex function, and little less remarkable than the mechanical actions of sucking and digestion themselves. It seems indeed proper to suppose that the nervous mechanism for the 'control' of so complex a set of movements should be related to the deepest and most basal opposition in which the muscles are concerned, namely the functions of extension and of flexion, of increasing and of decreasing respectively the general superficies of the body. Imitation has clearly little or nothing to do with the original process of the smile, for many weeks after the child can smile to perfection, he is totally unable to imitate even the bending of a finger although the simple act be performed a hundred times before his eyes. It must surely be judged that the smile is wholly instinctive and in a sense reflex, a psychophysical characteristic of at least the human young by the inherited law and structure of its being.

The biologic purpose and value of the smile and laugh are not far to seek, not much further indeed than are those of the expression of grief and pain as the appeals of the crying needs of the child to his mother: both of these are obviously biologically protective and preservative. A glance at the usefulness of the smile will show what in part has made it so invariably an aspect of the psychophysical life of man, and, doubtless by imitation, perhaps of some of the highest brutes. In the infant the smile very early becomes the index of the parental attitude toward him, and hence, because of its great biologic interest for his personality, he is apt instinctively to become at a surprisingly early period fairly learned in the physiognomy of the smiling, as of the frowning, face. Again, when the time has come in the course of nature that the young man acquires a highly specialized interest in one of the opposite sex, the smile becomes to a quite characteristic degree the object both of admiration and of further study. Later on, in business life, the smile, as exponent of the emotional attitude of those with whom the struggle for existence puts the man into some sort or other of competition, becomes even commercially important, and when an individual has profited so well by his long subconscious study of smile physiognomy that he can in general distinguish the natural or true smile from that of him who can smile and smile and be a villain still, his education in this direction may be called complete. It is because the smile is normally the indication of a pleased friendliness that it plays so important a part in the serious affairs of social intercourse, as useful as such to the schemer and the rogue as to the one enjoying properly the pleasurable society of his friends.

In his classic treatise on emotional expression Darwin gives the results of his numerous inquiries of persons in all parts of the earth as to laughter among savage races, and these were invariably to the effect that the phenomena is identical among them all: the seemingly wretched dweller in Terra del Fuego or the pigmy in the dark forest of the heart of Africa smiles precisely as does the newly made peer of Britain when he is alone, and for a precisely similar reason—because he is at that moment unusually happy. The cannibal may laugh at the contortions of his victim roasting in the fire before him, and the pampered infant in his nurse's arms may be wreathed in smiles at the prospect of another sugared 'cookie,' but the process in the two cases is not different and the physiologic cause is the same—pleasure, or the prospect of pleasure in itself pleasant. Dogs and monkeys are not infrequently seen to smile, and there are many who consider certain joyous manifestations in other animals as properly laughter. The nearly continuous state of smiling or laughter often seen in the case of imbeciles may obviously be taken as the reflex organic co-ordinate of that constant tone of pleasantness which these persons doubtless usually experience. The limitation of intelligence in these subjects makes it impossible for them to realize the serious burdens of life, while the somatic process, to an awareness of which their consciousness is often reduced, certainly gives as its psychic tone a complex sense of pleasantness or even of pleasure. It is on this account that in very young children, savages, and imbeciles the smile is to be observed at its purest, physiologically speaking.

Aside from innumerable references and descriptions, throughout general literature, of the phenomena we are discussing, the technical treatises on their physiology have been relatively numerous in all ages, although many of the books which pretend to explain laughter are really treatises on wit or on humor or on both, and contain little or nothing physiological, while the riddle why humor causes laughter and what the former is withal, is still as far as ever, apparently, from its interesting solution. It is sufficient for us that we ignore wit and humor, and begin with the *pleasantness* which these, together with innumerable other causes, produce in the soul. With this we may start with entire confidence, for, save perhaps in rare abnormal cases, the smile and laugh are everywhere the natural 'expression,' or, better, correlates, of pleasantness or joy in the individual. What, then, are the bodily accompaniments of general pleasantness in the human animal? The more conspicuous of the reactions may be suggested as follows, which later on we shall endeavor to explain and to account for.

There occur in laughter and more or less in smiling, clonic spasms of the diaphragm in number ordinarily about eighteen perhaps, and contraction of most of the muscles of the face. The upper side of the mouth and its corners are drawn upward. The upper eyelid is elevated, as are also, to some extent, the brows, the skin over the glabella, and the upper lip, while the skin at the outer canthi of the eyes is characteristically puckered. The nostrils are moderately dilated and drawn upward, the tongue slightly extended, and the cheeks distended and drawn somewhat upward; in persons with the pinnal muscles largely developed, the pinnae tend to incline forwards. The lower jaw vibrates or is somewhat withdrawn (doubtless to afford all possible air to the distending lungs), and the head, in extreme laughter, is thrown backward; the trunk is straightened even to the beginning of bending backward, until (and this usually happens soon), fatigue-pain in the diaphragm and accessory abdominal muscles causes a marked proper flexion of the trunk for its relief. The

whole arterial vascular system is dilated, with consequent blushing from the effect on the dermal capillaries of the face and neck, and at times of the scalp and hands. From this same cause in the main the eyes often slightly bulge forwards and the lachrymal gland becomes active, ordinarily to a degree only to cause a 'brightening' of the eyes, but often to such an extent that the tears overflow entirely their proper channels. The whole glandular system of the body seems to be likewise regularly stimulated (pleasantness being sthenic to the organism), causing the secretions, gastric, salivary, sudoral, mammary, genital, to be augmented, with a consequent rise of body-temperature and a general expansion of cellular activity. Volubility is almost regularly increased, and is indeed one of the most sensitive and constant of the psychophysical signs of moderate delight, although often quite inhibited in the excessive degrees of joy.

In the true scientific spirit, without thought doubtless of desecrating the fame of 'the human face divine,' the most beautiful of things, Angelo Mosso calls the face 'a muscular funnel at the end of the alimentary canal,' and in an interesting way he accounts for the complexity of its muscular portions by the obvious needs of seizing, masticating, seeing, etc. Moreover he points out four reasons why the facial muscles are so mobile, and these are as follows: first, because of their small size; secondly, because of their continual usage; thirdly, because of the close connection of their motor nerve, the Seventh or Facial, with the deep-lying cerebral centers; and lastly, because, as he thinks, there is no mechanical opposition between them. Accepting the first three of these as undoubtedly valid, with the last it seems from considerations soon to be suggested necessary to disagree, because it is probably erroneous. It is going back even to Aristotle to maintain that function is more fundamental than structure, and a reminder of the affective opposition which obtains in the face in the conditions on the one hand of joy and on the other of grief is all that is required. In the one case the features may be considered as drawn upward and in the other as drawn down. But in structure as well as in affective functioning, the opposition between these small and numerous bundles of muscular fibres may be clearly demonstrated if only the research be conducted at the proper period of development, the fœtal, and if only the neural paths and centers by which these muscles are directed be considered as part of their mechanism, as is philosophically necessary. From no point of view other than this is there structural opposition between any of the muscles, for histologically all, throughout the body, are similar (save as regard differences which are here beside the point). It is in fine a portion of our present thesis that the muscles of the face are extensor or flexor as are the other muscles, for the most part, of the body—an opposition at once functional and morphologic.

Now continuing to confine ourselves mainly to the facial manifestations of the bodily side of laughter (for it is here that the greatest general interest lies), let us see what are the broad general principles or biologic tendencies which underlie and make the smile and laugh what in fact it is.

In a monograph named 'The Emotion of Joy' (Macmillans, April, 1899), the writer summarized the results from nearly three years of research in the psychological laboratories of Harvard and Columbia Universities into the bodily processes which respectively correspond to pleasant and to unpleasant periods of consciousness. Some thousands of experiments made during that time on normal subjects (mostly students and professors of philosophy), demonstrated among other things that even in animals

so far from biological näiveté as these, there exists a psychophysical principle which can be concisely stated as follows: *In general, states of pleasant consciousness are correlated in the body by contraction of muscles classed as extensor, and, conversely, states of unpleasantness with contraction of flexor muscles.* This is an ancient and more or less popular hypothesis, but usually in a form where bodily expansion and contraction are suggested rather than muscular extension and flexion respectively, a tendency indeed which is to be observed in very many animals from the amœba, the type, upward in morphologic complexity. This expansion-flexion tendency, so to call it for convenience, being then an inherent opposition in the neuro-muscular structure of animal organism in general, its relations to the hitherto mysterious phenomena of the smile are of a certain general interest. Now it appears, in short, that *the smile and laugh are in fact fully explained by this general biologic principle*, as will become clear from the following considerations:

Even as the affective principles are manifested as early as animal life itself, so must one search very early in the morphologic changes of the individual, very likely indeed in the early stages of the embryo, for the forms which normally determine adult affective structure and function. Function is properly more primary than form, and one generation determines by its habits to some extent invariably the structure of the next; we should look, then, to the early embryo for the direct correlation of the functions which are to obtain in the adult life. At any rate, in the fœtus we find conditions, more plainly marked than in later states, which make adult functional relations clear. Although the 'primitive streak' is at first necessarily straight, folding begins very early, and at the end of the first month, in the human fœtus, the embryo is bent upon itself to a very marked degree. The curve which forms in the region afterwards the lower cervical is for our purpose the most significant, although the growth forward of the anterior lobes helps in the case of man to make this antero-posterior bending more marked and physiologically more significant. This curvature remains quite patent in the adult in all the canals which extend from before backwards in the head: First, in the ventricles of the brain from the third to the 'sixth' down the spinal cord. Second, from the nostrils upward and backward and then downward into the trachea. Third, from the mouth similarly upward and backward and downward into the œsophagus. All these in a proper philosophic sense outline even in the adult forms the curve which, at the period of individual development when the functions of the muscular system were being firmly established in the formative plan of the organism, is even more plainly apparent. In the strongly prognathous type of structure these conditions are all emphasized, as they are in animals with long probosces which these muscles in part serve to extend. It is at this very early formative period that the neuro-muscular system is beginning to take on its basal opposition of flexion and extension, the large muscle of the scalp, the Occipito frontalis, being the strikingly complete type of this far-reaching functional division, for the frontal half draws directly backward in a way to tend to extend the face and the head.

On this same dual principle do all the facial muscles act, as may be seen from a brief technical rehearsal of the most important of them and their functions. The Risorius, the 'laughing muscle,' draws upward and backward the corners of the mouth; the Zygomatici have a similar action on the lower jaw; the Levator labii superioris, as its name perhaps sufficiently implies, lifts the upper lip, as does the Levator labii superioris et alæque nasi, and in addi-

tion the outer and lower walls of the nostrils; the Levator menti lifts the soft parts of the chin; the upper portion of the Orbicularis palpebrarum raises the skin about the eyes, and the Pyramidalis that over the root of the nose; the Dilatores nasi lift and expand the lower portions of the nose; the Rectus oculi superior rotates upward the ball of the eye; and the Corrugator supercillii raises the inner ends of the eyebrows until the latter are straight. Thus all these, physiologically speaking, tend when they contract to straighten the curve which, morphologically, extends from the upper portion of the vertebral column upwards, forwards, and then somewhat downwards to the chin, and hence by this fact they tend to complete what is biologically the extension of the body.

It is thus seen that those muscles of the face which take part in or actually produce the facial portion of the 'expression' of joyful emotion, those in other words which by their movement constitute the smile and laugh, are extensor in the same sense as are those of the hand, neck, forearm, leg, and trunk, whose contraction has been previously demonstrated (see research referred to above) to be correlate with the pleasantness of the individual's experience at the time, although it is evident that the general form of the face and its complex functions make this myologic division of function less obvious than in case of the muscles of the rest of the body. The smile is then nothing exceptional, and is no more mysterious than is this general duality of action which obtains in every portion, apparently, of the muscular and neural mechanism.

Study of unpleasant affective states negatively corroborates, as we have already suggested, this explanation of the nature of the smile and facial laugh by exhibiting quite the opposite muscular reactions, as the term 'long face' so well implies in common speech. In disagreeable periods of experience the head, furthermore, is apt to be bowed, the eyes downcast, the eyelids lowered, and the corners of the mouth and the skin of the forehead drawn down. This opposition was the basis doubtless of the 'principle of antithesis' announced by Darwin the second of his principles of expression, and which has met with so great resistance from many modern physiognomists; it now appears in a new and a much stronger light as indeed a deep-lying tendency in living organisms.

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*Report on the Work of the Morrill Geological Expeditions of the University of Nebraska.**

Through the generosity of the Hon. Charles H. Morrill, of Lincoln, the expeditions sent out from the University of Nebraska, known as the Morrill Geological Expeditions, have become a permanent organization of the University. Therefore, it is but a fitting mark of respect that reports of these expeditions be given to the Nebraska Academy of Science from time to time in order that they may become matters of record. Introductory to this work, a private geological excursion was undertaken in June of 1891, by Mr. Erwin Hinckley Barbour in the interest of the University of Nebraska. At this time the Dæmonelix beds of our State were discovered and explored, and the Bad Lands of Nebraska and regions in South Dakota were visited, the result being that a very considerable collection was made and several new genera and species found. In May of 1892 a second trip (likewise at private expense) was made to the Sioux county Bad Lands and to the Dæmonelix beds. Again a large amount of material was secured and added to the collections of the State Museum. At this

*Paper read before the Nebraska Academy of Science.