

THE RELATION OF AUDITORY RHYTHM TO NERVOUS DISCHARGE.

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The term rhythm has commonly been employed in two acceptations. In its elementary signification the word describes a succession of events which follow one another with temporal uniformity; in sensory experience it is the periodic recurrence of a given stimulation; in connection with the sequences of auditory sensation it is the regular succession of sounds and silences. Such rhythms have been called *primary*. The second form, in contradistinction from the preceding, has been called *secondary rhythm*. It involves not only the regular recurrence of sensory stimuli but also a periodic differentiation among them. In this form of rhythm the unit is not a single element of sound but a group of such elements. Each of these unit groups is composed of all the sensory components lying between any one occurrence of the periodic differentiation and its proximal return.

Concerning the basis of this unification and segregation of groups theories have been advanced depending upon either of two factors, or upon their combination. It has been said that the essential principle of all rhythmical synthesis is to be sought in the temporal grouping of the sensations which support it. It has been asserted, on the contrary, that it is dependent solely upon the accentual variations whose recurrence characterizes the series. It has been urged, finally, that it is conditioned upon both of these aspects equally.¹ In the report of an experimental investigation on rhythm, published by the

¹Theories of temporal synthesis : Hauptmann, Herbart, Lotze, Westphal. Theories of accentual synthesis : Guest, Tyrwhitt, Kostlin. Theories of interdependence : Meumann, Riemann.

writer in a monograph supplement of this periodical,¹ it was maintained that only the third of these hypotheses is consistent with the facts. No rhythm is presented by a series which perfectly fulfils the temporal conditions, so long as no recurrent accentual differentiation arises; and such recurrences of accent, on the other hand, are equally unable to support the impression of rhythm unless they fulfil specific temporal conditions in the form of their succession.

The elementary condition of the rhythm phenomenon is the periodic accentuation of an auditory succession occurring under specific temporal relations. While accentuation is essential to the appearance of rhythm, no specific mechanism is necessarily involved in its production. If forms of objective differentiation appear in the material, the variations which support the impression of rhythm may be indifferently of the intensity, quality or duration of the stimuli. Rhythm, therefore, does not consist of the presentation in consciousness of a regularly recurrent intensification of certain elements in a succession of auditory stimulations, for the impression is as distinct and adequate when the only differentiation presented by the series consists of a periodic lengthening of the component sounds or intervals. If the nature of the experience as a modification of consciousness be the same in these various cases, the essential constituents of the impression must be looked for elsewhere than in the special nature of the qualitative types of variation embodied in the sensory series, especially when there is taken into account also the fact that this impression is aroused when all such objective differences are absent, and the sole condition is observed that the stimuli follow one another at a certain rate.

The impression of rhythm depends, secondly, upon the repetition of the periodic differentiation manifested by the sensory series. That impression never arises from the presentation of a single differentiation period; it does appear at once and perfectly with its first recurrence. In other words, a simple measure cannot constitute a rhythmical sequence; two

¹ 'The Constitution of Simple Rhythm Forms.' Harvard Psychological Studies, Vol. I (Monograph Supplement 17); now in press.

such measures do so, and two measures form the simplest conceivable rhythm. In every concrete impression of rhythm two factors are involved: Firstly, a formal element which consists in an ideal scheme of relations which the sequence fulfils, and which contributes to the series of impressions a *Gestaltsqualitat*; and, secondly, a material or time-filling element which consists in the repetition of functionally equivalent simple groups which constitute the structural elements of that ideal sequence. Recurrence is essential to the movement of the rhythm only, not to its form. The latter is apprehended immediately and completely upon a single recurrence of the rhythm group or period. As the rhythmical sequence advances the apprehension of form can be affected only by complication, that is, by the rise of new rhythmic forms into which the originally apprehended simple group enters as an elementary constituent. At each step the whole character of the rhythm is given up to that grade of synthesis which the total series presents. The simple measure, the verse, the stanza, and those poems which, like the sonnet, possess a distinct figuration are severally independent rhythmical forms, each of which is apprehended through a single presentation of its structure.

Such forms are not in themselves rhythms. The impression of rhythm arises only when these formal relations are embodied in a concrete movement. Formally adequate successions are constantly presented in our experience without arousing any impression of rhythm. Under certain circumstances the single occurrence of a rhythmically related group of sounds may give rise to the impression of rhythm, namely, when the melody which contains it is familiar, or the mind is pervaded by a tendency to rhythmical expression of this particular form. In such cases, however, the simple measure does not contain the rhythm, but only initiates a process the continuance of which supports the experience.

In the third place, the impression of rhythm arises only under the maintenance of specific temporal conditions in the succession of sensory stimuli which support it. Though the superior and inferior limits of the absolute rates of succession which condition the feeling of rhythm in a series of sounds

have been variously reported by different observers, these divergences presuppose in all cases the indubitable existence of such limits. Intensive subordination among the elements of the objective series and periodicity in their recurrence are by themselves wholly insufficient to give rise to the feeling of rhythm. Were the impression dependent solely upon a perception of the maintenance of such relations in a series of auditory stimulations, the temporal limits to the experience which are actually encountered would be inconceivable. We do thus conceptually speak of geological rhythms, but this is a figurative projection of the term into realms which our experience can never penetrate. One may conceive the existence of a consciousness upon which such a series of stimulations would produce an impression of rhythm, but for the human consciousness it is forever unrhythmical, and no amount of effort at conceiving it in this way will avail to give one the peculiar experience of 'feeling a rhythm' in it. That experience is as new and different from the apprehension of the isolated elements of a slower series as the continuous musical tone produced by a siren is different from the succession of puffs which one hears when the mechanism revolves at a slower rate.

The facts involved in the elementary conditions of the rhythm impression which have important theoretic bearing may then be stated shortly as follows: First, the process of accentuation is not necessarily connected with any specific type of objective change and may arise in their absence. It must therefore be an activity which these objective factors occasion only and do not contain, and its appearance is most closely connected with the temporal relations embodied in the series. Second, the scheme of a rhythm group, in its temporal and intensive relations, gives only the formal conditions for the appearance of the rhythm impression. For its realization the accentuation of certain elements of the series must be periodically renewed, and this repetition of functionally integrated groups persists through all grades of structural synthesis. Third, of all the possible rates of succession which a series of auditory sensations may present the feeling of rhythm accompanies those only which fall within a narrowly limited range.

Above and below these limits the succession of stimuli fails to support the experience. It cannot there be mediated either through the intensification of objective accentual differences, nor by reinforcement through any type of subjective emphasis.

Upon the intimate nature of the process of rhythmical accentuation in its relation to the phenomena of temporal limits must turn our theories as to the nature and fundamental conditions of the rhythm experience. In the analysis of this process it is important to discriminate purely rhythmic factors from concomitant but independent elements of experience. To the latter class belong all complications and enrichment of the bare limiting stimuli upon which the definition of periodicity depends. It is necessary, above all, to inquire by what means the rhythm experience is superinduced upon the presentation of stimuli which do not manifest those differences with which its arousal is ordinarily connected. The existence of such contributed or subjective forms makes it necessary to take into account the possibility of its presence as a transforming agency in every experience of rhythm, objective as well as subjective. If it create rhythm where none previously existed, it may complicate and enrich simple rhythm forms produced by the voice or instrument which affords the sensory material of experience. In point of fact this subjective contribution is not restricted to series from which intensive and temporal differences have been eliminated. It appears equally in the organization of recurrent forms which possess a distinct objective configuration. Under specific conditions of temporal succession such identically repeated forms—for example, successions of rapidly uttered dactyls—are subjectively differentiated into alternate groups having the relation of major and minor phases, in which both temporal and intensive values are quantitatively unlike for the apprehension of the hearer. Upon this constant subtle accompaniment the characteristic form and affective overtone of the rhythm impression in some degree depend, and it is at least conceivable that the essential element of the experience should lie in the subjective contribution itself—that rhythm is never a fact of perception alone, but essentially involves an active attitude on the part of the apperceiving subject. This is the conception to

which the writer was led in the course of the investigation already referred to, and the point of view may be stated in a few words. *Rhythm is always produced.* The bare auditory perception of a series of sounds, the uniformity of which is broken by periodic reinforcements, no more affords the peculiar experience of rhythm than does the perception of those visual symbols which represent the relations of such a series of sounds in musical notation. The successive stimulations must start a series of motor impulses somewhere before its rhythm is felt. Apart from such a pulse of bodily change the perception of a rhythmical series of sounds would be the bare abstract apprehension of their varying intensities and intervals.

The fundamental conditions of the rhythm experience are therefore to be looked for in the laws of periodicity of functioning in the bodily organism. It is because these processes take place under conditions of regularly recurrent change that the time element becomes important in rhythmical sequences. The existence of beautifully proportioned durations in rhythm is a purely derivative fact. We do not take pleasure in such series because of the proportion or simplicity of their relations, but because their patterns are reproductions of the natural forms of our own activities. The pleasure which rhythm affords arises from the coincidence of subjective and objective change.

In regard to the nature of the mechanism involved in this process of subjective activity, with the phases of which the elements of objective stimulation must be specifically coordinated in order that the impression of rhythm shall arise, we may conceive, in the first place, a periodical facilitation and inhibition of nervous activity to arise from the relation between the periodicity of its own rhythm of functioning and certain intervals in the objective series of stimulations. If such a physiological rhythm appears in the functioning of the central nervous system, a periodic increase and decrease should occur in the intensity of the sensations coordinated with a series of unchanging stimulations, according as its elements were correlated with positive or negative phases of the nervous activity. The effect would be analogous to that consequent upon successive tensions and relaxations in the drum of the ear, and the rhythm must be

called, in so far as the sensory experience is concerned, an objective rhythm, illusion arising only in connection with the interpretation of the source of the positive changes which appear in consciousness. In the second place, we may conceive the succession of auditory stimulations to arouse a parallel motor accompaniment in the form of sensation reflexes occurring in some part of the bodily organism. The impression of rhythm under this conception is due to a system of kinæsthetic sensations whereby periodic elements of the primary auditory series are reinforced in such a way that the whole sum of sensational material rhythmically increases and decreases. This active accompaniment may be conceived to take the form either of an accentuation of certain members of the series only, or of a continuous accompaniment in which a reaction is coördinated with every element of sensation, the violence of the motor discharge periodically increasing at those points in the series which form the successive accents. Here, also, there is present in consciousness a real rhythmical series, but it is the accompaniment, not the original sequence of sensations, which is thus characterized. Both of these relations between the rhythmically repeated stimulation and the nervous activity, namely, functional facilitation and reflex motor discharge, I conceive to be represented in the conditions which support the impression of rhythm. The sole existence of the former type of effect is the theoretic limit of a process which in its actual occurrence always involves elements of the latter kind.

The components of this rhythmical accompaniment present wide variations. The muscular contractions which mediate it are to be looked for among the most mobile members of the body. The tongue, the head, the jaws, the fingers and the feet are visibly employed in keeping time to rhythmical stimuli. Of greater prevalence but much more difficult of observation are contractions giving rise to sensations of strain in the throat, head, chest and limbs, tensions in the vocal and respiratory muscles, and above all the simultaneous innervation of opposed sets of extensor and flexor muscles producing alternate phases of rigidity and relaxation which do not affect the local relations of the organ in which they take place. In the apprehension of

rhythm forms this kinæsthetic comment appears ineradicable. For each individual the inhibition of the natural set of motor accompaniments interferes with the impression of the rhythm. In many cases when these expressive movements are eliminated the sense of rhythm is lost. The process of voluntary inhibition of particular modes of apprehending rhythmical material consists in breaking up the special set of motor emphases which supports that form of perception. The endeavor to apprehend the sensory sequence under a different rhythm form is uniformly accompanied by the motor emphasis of those accentual points which are characteristic of the novel rhythm. In the attempt to perceive as monotonous an undifferentiated series of sounds which has hitherto supported a subjective rhythm the recurrent motor accentuations of the previously dominant rhythm are got rid of, not by a suppression of all accompaniment, but by the equal emphasis of each element as it appears. Finally, the voluntary inhibition of such sensation reflexes is a process which affects only a limited number of factors; it cannot be carried out in any completeness. Sufficient rhythmical accompaniment may in all cases escape notice to give definiteness and character to the rhythm.

This process of secondary motor response is not necessarily confined to the voluntary muscle groups. It may be reflected into the mechanisms of accommodation in the organs of perception through the periodical renewal of sensorial attention. The effort to attend to a sensory stimulus involves, as part of the concomitant organic adjustment, an adaptive change in the condition of the sensory apparatus which increases the sensitiveness of its response to incoming stimuli. Every return of the attitude of attention to auditory stimulation temporarily sharpens the sense of hearing by drawing to a nicer tension the membranes of the drum of the ear. In such a case we have to do with a process which is not itself the object of voluntary adjustment but the secondary result of such an activity. For periodicity in the recurrence of such an attitude we may look to either of the two sources already stated, a physiological rhythm in the nervous mechanism of sense perception itself, whereby the tonicity of the organ suffers regularly recurrent changes, or an

adaptive process concomitant with the rhythmical motor accompaniment of the sensory series, those elements which are emphasized being likewise more closely attended to, and thereby receiving reinforcement as sensation intensities. The pulses of attention in the apprehension of rhythm are at least not more rapid than the recurrence of the simple group, for such structural units are without exception apperceived as unities and not as a succession of separable parts.

In the rhythmization of undifferentiated auditory material the relation of the processes of sensory accommodation and motor innervation to the stimulation series becomes of paramount importance. In it, while the rhythmical form is a purely subjective contribution, the illusion of objective differentiation is complete. Subjective rhythm appears only under temporal relations of narrower range than those which condition objective forms, but within these limits it arises spontaneously. It is not, however, strictly or uniformly uncontrollable; the establishment of such a form of apprehension does not necessarily involve its perpetuation during the continuance of the auditory series. In certain cases the mere attending to the apparent rhythm causes its disappearance. When of a more integrated type the rhythm is commonly suppressed if each element be regarded in isolation from the succession of which it forms a part. When attention drifts away and the series of sounds — or as much as can be grasped in a single act of attention — is regarded as a whole, the rhythmic differentiation reappears. In more obstinate cases the method of breaking up the rhythm is to emphasize, by a more or less violent reaction, those elements which fall into unaccented positions in the series or to emphasize equally each sound as it appears. The rhythmic apprehension of undifferentiated material is also subject to frequent fluctuations both in its form and continuity. It appears, undergoes change of structure, is dissolved and reappears within relatively short periods of time. When the experience is supported by the conception of an ideal form which the series of stimuli fulfills, the apprehension of the material in a single mode may be indefinitely prolonged. In the experience of rhythm, then, whether supported by a succession of sensa-

tions presenting figured groups, or by a uniform series, there is presented a process of apprehension penetrated at every point by secondary motor impulses.

It will help us to understand the way in which this motor accompaniment is aroused in the presence of a rhythmical series of sounds if we recall the primitive relations of reaction to stimulation. In concise form it may thus be stated: Every presentation tends to arouse some movement. In kind this movement is imitative of the original. A succession of regularly recurrent stimuli, therefore, tends to set up a process of rhythmical movement. Not to accompany the presentation of a stimulus in this way indicates inhibition of some sort.

But this is not an explanation of the tendency to prefer one type of movement to another, to imitate a rhythmical but not an unrhythmical series of stimulations. The unrhythmical succession is vastly more frequent in our experience than the rhythmical. If the establishment of particular types of organized movement depended upon the frequency with which the like relations were presented in the world of our objective experience, we should prefer forms of irregular movement. The actual tendency, on the contrary, is toward the embodiment rhythmical relations in our movements; we maintain a tempo, we beat time, we accompany a rhythmical series of sounds but not an irregularly recurring series. The relation to experience is not that of the establishment of a simple correspondence of subjective habit with objective conditions.

There is present in such processes a factor which is reinforced by stimuli occurring in periodic succession but which is unsupported, or inhibited, by unrhythmical series. This is the law of nervous action in virtue of which the form of a movement once originated tends to be perpetuated. The kinæsthetic sensation aroused by the perception-reflex, or imitative reaction, is itself a presentation having the nature of an incitement to the repetition of the movement. It partakes of the character of the original stimulus which provoked the primary reaction, and tends to bring about again a discharge into the same complex of muscles. Thus, in a nervous system uncomplicated by other simultaneously active processes, the origina-

tion of any movement tends toward the establishment of a rhythmical series of reactions by the reciprocal arousal of movement and kinæsthetic sensation within a single closed arc.

This primitive condition of activity is disturbed, in the organism possessed of a highly developed nervous system, both through the interference of intense outward stimulations occurring at irregular intervals, and by counter-suggestions to action of a conflicting type where ideal associations are present. Even in such organisms when these factors of complication are withdrawn the process may spin itself out indefinitely. This dissociation of the motor process from the control of ideal associations takes place under both normal and pathological conditions. In the normal subject it is presented in states of inattention to those minor tensions and reactions of the body which are either mechanized or unconnected with the purposeful activity of the moment. Such are the rhythmical liltng, thrumming and beating of time into which the mobile fingers and tongue fall during moods of idleness or abstraction, and the larger innervation processes of the body which have grown thoroughly habitual, such as the series of reactions by which the process of walking is carried on. The same sequence of relations is presented, in connection with a simpler type of associative system, in the habit of young children endlessly to repeat single sounds or imitative movements.

The pathological forms of this process are many. It appears during the transient suspensions of rational control occurring in fever delirium, in the meaningless repetition by the patient of a word or syllable which he has uttered or heard. It is presented in the tetanic innervation of the muscular system characteristic of catalepsy, and is probably represented also in the continued reproduction of a suggested movement by the hypnotic subject until the process is arrested by the hypnotizer. It is manifested in more pronounced and obstinate forms among idiots and the insane, where its exaggerated and persistent types have led to the coining of the descriptive term 'echolalia.' I cannot agree with Professor Ziehen's extension of a pleasure valence to the origin of these reactions, though accepting his first statement without reserve when he says: "As regards the

succession of sensations, therefore, a regular periodicity is the chief condition for the appearance of feelings of pleasure. It is not mere chance that maniacs and those afflicted with emotional paranoia often speak in rhythm and rhyme. Such phenomena harmonize rather with the morbid, positive emotional states characterizing these forms of psychosis."¹ These are forms of activity to be explained not by the concept of a deliberate pleasure-seeking but as the expression of a primitive, uncontrollable impulse to utterance, a reversion to a simpler type of activity, in which the elementary rhythms of motor innervation are uncomplicated by a richly developed system of associated ideas.²

The general conditions underlying all these phenomena are characterized by simplicity or primitiveness in comparison with the workings of the normal mature nervous system—conditions in which the sensori-motor arc manifesting activity is in relative functional isolation, such that the interferences with its characteristic forms of innervation by other simultaneously active brain processes are reduced to a minimum. Primitively it needs not a regular succession of sound stimulations, an objective rhythm, to establish a rhythmical series of movements; a single originating stimulus, if it be sufficient to bring about the initial reaction, will thus serve to set up a succession of repetitions. The fortune of this series of reverberations does not depend solely upon the type of functioning represented by the nervous arc within which the reciprocal movements are conceived to take place. It is subject to influences both from beyond the organism and from within it, either of which may tend toward reinforcement, on the one hand, or inhibition, on the other; and upon the relation of the sum of these extraneous factors to the arc primarily excited the subsequent course of the series of reactions depends.

¹ Ziehen: 'Physiological Psychology,' p. 148.

² This is characteristic also of the spontaneous rhythmization of rapidly succeeding homogeneous sounds, of which one observer in the experiments already referred to writes: "I certainly never try to do it; and, so far as I can see, it is never prompted by any desire to get satisfaction. It seems to be a spontaneous act, which when it arises causes satisfaction in a very slight degree."

Reinforcement of the primitive tendency to repetition may come either from a regularly repeated external stimulation,¹ or from the idea of a series of rhythmical movements to be carried out. The process set up by a single stimulation is unlikely, under any actual set of conditions, to establish successfully a system of rhythmical movements. The probabilities are immeasurably in favor of its being lost in the complicated set of independent sensational and ideational activities with which the general system is throbbing. When, however, the original stimulation is regularly renewed, the waning process receives periodical reinforcement by positive increments of stimulation and the reactive motor accompaniment waxes from moment to moment until a fully developed set of rhythmical movements is established. Under this conception the character of the motor accompaniment, as also the intensity of the rhythm feeling, should undergo a certain growth. The former should not appear either so vigorous or so exactly coördinated in the first phases of response to the recurrent stimulation as in its later forms. We should expect it to be susceptible also of indefinite exaggeration until conceivably the diffusion of the wave of motor response involved the whole body in violent changes. As a matter of fact we know from common observation that the tendency to accompany an auditory rhythm by movements of the bodily members, by humming, liting and singing in tune, by beating time with finger, or foot, or head, by waving the arms, swaying the body, etc., does not arise at once upon the initial stimulation, nor is it at first fully developed. It manifests a period of latency and a process of growth, requiring an appreciable time to attain its maximum. One can observe this

¹Within the category of such external stimulations we must of course include the secondary sensations, of sight and sound, which accompany the kinæsthetic feelings as common products of the movements involved in beating out a rhythm. The exactness and perpetuation of the rhythm habit depend upon the nature of these derivatives of the motor reaction, as well as upon the resident sensations themselves. In proportion as these limiting stimuli become distinct and forcible does their value as incentives to the repetition of the reaction increase. Sensations of movement, kinæsthetic and visual, of resistance, and of sound all combine to reinforce the intensity of the rhythm activity; and it is probable that the most effective union of resident with secondary sensations is attained in the process of vocal utterance.

reinforcement in the manner in which an audience accompanies a piece of music by gradually increasing movement until the whole roomful of persons is swaying and beating to the rhythm like a single instrument.

One may mark its persistence, too, in the difficulty met with in the attempt to break up such a system of rhythmical movements when once thoroughly set agoing. The obstinate running through the head, even to a pitch of distress, of a tune which one has heard, the habits of strumming and liltng which establish themselves as the reflex accompaniments of the return of certain attitudes, and which cannot be shaken off, are examples of this tendency. We should include within the same category the fact that the subjective rhythm which appears when uniform sounds follow one another at certain intervals of time does not manifest itself at once on the inception of the series, as is the case with the earliest measures of an objective rhythm, but develops slowly, the appearance of this contributed rhythm being dependent, as has been already said, upon the development of a rhythmical process of discharge within the motor centers. As the concomitant of such a developing system of reactions within the organism we should look for an increase in the affective over-tone, and this mounting rhythm feeling, with its undeniable pleasurable quality, is doubtless itself a positive factor in accentuating and perpetuating the process.

We should also be prepared to find a development of sensitiveness to rhythmical relations, manifested in a progress toward uniformity among the successive reactions and a refinement of perception in regard to irregularities occurring within the series of stimulations. Both of these forms of change appear in the results of the experimental investigation already referred to. On the one hand, both unit measures and larger series of reactions show a progressive integration, manifested in the reduction of the indices of mean variation, and on the other, the threshold of just discernible variation from type of structure is similarly lowered as the series of rhythmical sounds advances toward its close.

It is obvious that in the setting up of such an organic rhythmical accompaniment the temporal relation of the series of stimu-

lations to the nervous habit of the organism must be a factor of great importance. If there is to be objective reinforcement of an organic tendency to reproduce the movement, the phases of the two processes must coincide, or at least approach within the limits of adjustment on the part of the organism. The elements of a regularly recurrent stimulation may be conceived to exert an inhibitive influence equally well with any incidental or irregular form of excitation, if its periodic phases are in opposition to those of the natural rhythm of the sensori-motor process itself. Similarly, it will altogether fail to support the tendency if its recurrences are so infrequent that the impulse to reaction has died out before the following stimulation takes place. What particular intervals between successive stimuli are most favorable to the establishment of the process is a matter to be determined empirically by direct experimentation; but apart from the actual determination of the values of such limits we should expect that the tendency to rhythmize indifferent sensory stimuli, or to accompany them by rhythmical movements, will depend upon the relation of their absolute rate of succession to the natural rhythm of the bodily processes involved.

That such limits exist has long been established; it requires but slight observation to discover them. Below a certain rate they fail to arouse any involuntary response; between this and a superior limit the tendency to segregate and accentuate the material and to accompany it by motor reactions is practically uncontrollable; beyond this upper threshold the organic adjustments fail to follow the accelerated series, though here, under certain conditions, a new form of rhythmization may supplant the old, the impulses proceeding not from the single elements of stimulation serially but from the integration of successive groups which now replace those elements as units.

The rhythm activity, then, represents a relatively undifferentiated type of reaction. Its appearance as a spontaneous exercise and as a reflex accompaniment is a manifestation of the primitive tendency to reaction toward presented objects, and of an equally primitive tendency to perpetuate a movement once made. It belongs to a class of activities which we habitually connect with early ages of development and with the lower parts of the

nervous system. The opportunity for the outcropping of these primitive activities is presented under conditions in which the higher brain processes are inhibited, or reduced below their normal preponderance. In such temporary moods of the normal subject as revery and abstraction, in the lack of occupation and of mental strenuousness, we should look for conditions favorable to the development of spontaneous or reflex rhythm activities. Now it is just in such moments of relaxation and mental drifting, when consciousness is occupied with no serious or pressing duty, that the impulsive rhythm habit, humming, tapping, singing, and the like, and the reflex habit of accompanying any objective series of regularly recurrent stimulations, characteristically crop out. The active association of ideas is either suppressed or drafted off into an entirely different set of centers than those concerned in the production of the rhythmical reactions. We are either mentally vacant at the moment, and at the mercy of vagrant stimuli, or we are absorbed in some mental process which makes no tax on the periphery of the body, and are usually unaware at the moment of the rhythmical reaction process which, thus accidentally originated, is spinning itself out in the absence of inhibition from the higher centers of the brain.

Further, the persistent and exaggerated types of rhythmical motor activity presented in the abnormal conditions already referred to confirm this view of the relation of the rhythm habit to the general activity of consciousness. In fever delirium the processes of orderly association characteristic of normal life, by which random meaningless movements are inhibited, is interrupted, the primary reaction centers of the lower brain are released from the inhibitive control of the cortex, and the utterance or other movement, once originated, tends to a prolonged repetition, limited only by the final exhaustion of the muscular or nervous system. Similar conditions are presented in the tendency of children and idiots to prolong rhythmical repetitions of movements and to rhyme over sounds to themselves. The prevalence of the element of rhythm in primitive music and ceremonial is indicative of a lower stage of development than our civilized type. An indispensable condition of the

purity of the rhythm activity is its independence of a changing ideational content. The most perfect rhythm, whether simple repetition of a motor reaction at regular intervals, or the complex grouping of such rhythmic material into synthetic units, is that which is most free from secondary significance. Its movement is inevitably clogged when it is made a form in which to cast discursive thought. The most adequate rhythms are those which present only a pure sensory stimulus to the motor process, uncharged with symbolic value, which allow the attention to center in the reciprocal play within the sensori-motor arc, and make no draft upon it by a stream of changing ideas which the limiting stimuli are made to suggest. Its purest and most effective embodiment is found in such sequences as that of the drum-tap, the most potent incitement to the rhythm habit of all forms of auditory stimulation which have been invented. Add any new element to this perfect instrument and its effectiveness in arousing the feeling and evoking the accompaniment of rhythm is proportionally weakened. Introduce change of pitch and give melody to the series of sounds; combine the beating of the skin with the tones of vibrating strings, or pulsating air, or quivering reeds, in chords, harmonies and orchestral effects; above all, make the series of sounds which sustain the rhythm the vehicle for a train of mental images of objects and relations, with their ever-changing influence upon the direction of the attention process, and the rhythm is thereby impaired, proportionally to the capacity of the factors of melody, harmony, or rational significance to attract attention to themselves and away from the pure rhythmical element. "Almost every civilized country has its national melodies, in the form of songs, dances, or marches. While most of these melodies have remained local, some of them, particularly dances, have been taken up by the great masters and introduced into general musical literature; and though many of the original melodies have long been forgotten and changed, yet the form and characteristic elements of them have remained.

"The great masters who employed certain national dance-forms for special compositions, or introduced them in their greater works, although describing the general distinctions of

these dances, did not adhere strictly enough to the more detailed characteristics; and handled the form with such individual freedom that it became under their hands an artistic dance-form, but ceased to be a dance in the popular acceptation.

“Thus, the dances of Bach; the minuets of Hayden, Mozart, and Beethoven; the waltzes and polonaises of Schubert; the mazurkas, waltzes, and polonaises of Chopin, etc., are artistic forms; and not intended for practical dance purposes.”¹

The transposition and complication of accents which these art-forms involve disguise their primary rhythms, and make difficult or impossible the coördination with them of the rhythmic phases of movement upon which the dance depends. Dominant and effective rhythm can exist only in simple musical and poetical compositions. It is not in these compositions that the most highly differentiated and complexly organized types of rhythm are to be found; but in them the rhythm factor is greater relatively to the whole production. The person in whom discrimination of pitch-differences and melodic or harmonic relations is poor, and for whom the coordination of groups of tones is difficult, finds his enjoyment of musical performances in the pleasure of the immediate rhythm experience. When this is overlaid by those more complicated types of coördination which delight the trained musician's ear, his pleasure vanishes, for the composition then produces no distinct effect upon him, it gives no incentive to rhythmical accompaniment and appears only as a confused medley of sound. One gifted with a musical ear or trained in the appreciation of musical effects, who follows and enjoys such a composition, does not find his pleasure simply in a rhythm which is of a more synthetic type than his untrained neighbor is able to grasp. His attention is primarily attracted to other elements, to the sweep of melodic phrasing, the antiphony of passage to passage, and the larger unities of composition, which a rhythmical undertone of recurrent accentuation and analogy of form enables him conceptually to grasp. He does not feel the rhythm primitively and immediately as the other does that of his tattoo upon the table or his meaningless lilt; it does not provoke in him any dis-

¹ Christiani, A. F.: 'The Principles of Expression,' etc., pp. 93-95.

cernible type of motor response; it has lost its intrinsic significance for the æsthetic subject in whose consciousness it appears, and serves chiefly as a secondary means of extending the scope of the attention process in its effort to grasp an ever wider set of pleasurable stimuli.

Still more strikingly, when the rhythmical sounds are clothed with ideas, and the sensations which support the rhythm are at the same time the symbols of rational speech, does the association of these secondary factors with the fundamental element of the rhythm phenomenon interfere with the purity and power of its effect. Poetry, like the opera, is an irrational combination of two processes, either of which, for its free activity, presupposes the absence of the other. Rational thought, fit sequence of ideas, demands a free movement among complicated elements in which no precise periodic return to the same origin is conceivable; while just this condition of a never-ceasing repetition of similar forms of relationship is fundamental in every rhythm process. For the rhythm experience is one and the same in music and in verse, the vehicle of its expression alone differing in the two cases. The proportionate relations of rhythm are more exactly fulfilled in musical performances than in poetical recitation; for the material of music, as a set of symbols, is incomparably less definite than that of verse. The draft upon the attention in the former case leads constantly back to the immediate relations of quality, intensity and duration existing in the sensuous material itself. There is no parallel series of logically connected images, as in the case of poetry, to distract the mind from the changes in the sensory material by which they have been suggested. And the conditions of musical expression make it imperative to observe the laws of rhythm, since upon these depend in great measure the processes of comparison and coördination which are superimposed upon the immediate enjoyment of the sensory qualities which the music presents.

In poetic expression the function of rhythm is essentially more subordinate, then, than in that of music. The rhythm of poetry pulls in one direction; the thought it presents, in another. The most perfect of rhythmic verse-forms is found in the recita-

tion of nursery rhymes and nonsense jingles, where the reciter is least seduced from the production of a beautifully proportioned series of recurrent groups of motor reactions by the associations of vitally significant words. The high relative value of the rhythmical element in these compositions is not due to any unusual consonance between the orthographical and the rhythmical accents. On the contrary, as Sanford has pointed out, no other popular form of poetic writing makes such audacious demands upon the rhythm sense of its reader. Rests, elisions, prolongations, even transpositions of orthographical accent are freely made, yet the ordinary reader is carried securely through their complex changes. This is so because the maintenance of the formal key-note given by the verse structure and initial orthographic accents is rendered easy by the simplicity of their content as compared with other forms of poetical writing.

In proportion as the structure of the verse-form grows more complex, or the burden of thought more exacting in the demands which it makes upon the attention, this sense of rhythm fades. Only in those pieces in which there is a return of the thought upon itself periodically in the form of a refrain, or the meaningless repetitions (meaningless from the point of view of associative thought, but most significant in their relation to the function of rhythm) of folk-songs and nursery rhymes, can the words of the verse be said to reinforce the rhythm in any way—that is, only when, at the sacrifice of their intrinsic significance, the words are used as practically pure sensory rhythm elements. It is because of the disjunction between sounds as the material of rhythm and sounds as the symbols of rational speech, and their more specific correlation in the former case with a parallel set of motor innervations, that one has a more distinct feeling of rhythm in the spoken verse of a tongue with which one is unfamiliar than in that of one's own speech; that one best clarifies the rhythmic structure of a stanza by substituting for the significant words of the poet a lilting utterance of meaningless syllables; and that the 'music' of a poem may persistently haunt one, while the words and even the thought and general topic with which it is concerned are wholly irrecoverable.

In the relation of the successive sounds of a rhythmical sequence to a coördinated system of motor impulses is finally to be sought an understanding of the constitution of objective rhythm forms and the laws of their synthesis. These phenomena include the characteristic distribution of intensities within the unit group, the apparent accentuation of an element which arises from the simple extension of the interval following it, the exaggeration of the duration of the accented element and its following interval, and the concomitant variation of intervals in dependence upon the intensive magnitude of preceding elements. In connection with uttered rhythms our knowledge of the laws under which nervous discharges take place—such as the relation of intensity in the innervation to the temporal curves of latent period, contraction and release—makes possible the prediction of certain relations of stress and duration among the elements of the group. Under this concept the alternating phases of expectation and its fulfilment which characterize the experience of rhythm will be resolved into psychological attitudes which are physiologically conditioned by systems of strains and releases due to the rhythmical opposition of those phases of motor innervation which the reaction accompaniment involves. Not only in connection with uttered rhythms, but also in regard to the forms in which objective series are apprehended, this concept should find application; for in the latter case the same characteristic relations appear between stress and duration as in the former. These connections cannot be due to differences in the course of the sensory after-images resulting from intensively varying stimuli, for the causal relations between the two may be inverted, that sound which is prolonged or followed by a prolonged interval receiving apparent accentuation. Their conditions are to be sought rather in the system of motor discharges which the series of stimuli arouses, especially in its relation to the rhythmical renewal of sensorial attention and the temporal curve of the nervous changes involved in the mechanism of accommodation.