Some Effects of Music

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Some Effects of Music

In western Europe the effects of music, insofar as they are studied at all, are considered to come within the scope of aesthetics. Music is thought to be important because it is one medium through which we are exposed to the beautiful and to whatever is consonant with 'good taste' and until quite recent times those concerned with music would certainly have maintained that only 'good' music could produce good effects while 'bad' music would have either bad effects or no effect at all. Even in contexts where, ostensibly at least, the concern was not with aesthetics, as for example among those interested in 'music therapy', there was a strong tendency to believe that only 'good' music was likely to have a therapeutic effect. This very limited view of music has begun to break down under the pressure of changes such as the rapid spread of jazz and 'pop' music and the development of electronic music. Naturally the devotees of these kinds of music tend to develop their own aesthetic, but no one could deny the very powerful influence which these newer kinds of music have, nor successfully account for it on what was formerly held to be an aesthetic basis. The new music, in all its manifestations, has compelled many people to become aware that music can and does have a wide variety of effects.

This is one more illustration of the general principle that relatively little can be learned about a subject by approaching it exclusively from one direction. There is a growing realization that a great deal of fresh information and many new insights are to be gained from adopting a wide, cross-disciplinary approach to every subject of study and music is far from being an exception to this. The aesthetic view of music was basically a psychological, even in part a philosophical one, but it disregarded many of the psychological effects of music. Moreover, the human being is so constituted that psychological effects are accompanied and indeed mediated by physiological effects. In the case of music there is also obviously continual interaction between the physical character of the musical stimulus and its physiological and psychological effects so that a more thorough study of music would demand at least the combining of a physical, physiological and psychological approach. Modern science has relatively little information about the links between physics, physiology and psychology and is certainly not in a position to specify how the effects are related in music, but most scientists would recognize here a gap in

scientific knowledge and would not want to deny the fact of a connection.

The main purpose of this lecture is simply to point to some directions in which such an approach to music might lead and to illustrate them where possible by means of musical examples. These are drawn almost exclusively from the work of classical and romantic composers but this is only because such music is the most likely to be familiar to an audience.

Although the history of music as an art form is not very long compared with the history of man himself, nearly every period for which there are historical records offers some evidence of the making of music, however simple or crude the means employed may have been. Evidently there is some need in man which can be met by various forms of music. No doubt there are other ways in which the need can be satisfied, yet music itself has some features which mark it off from at least other artistic forms. While the visual arts, sculpture, drawing and painting, are all basically representational, music by its nature can scarcely be so. Imitation of natural sounds plays so small a part in music as to be negligible, whereas natural forms and sights have through the centuries constituted the raw material for the painter, however far he may sometimes wish to move in the direction of 'abstract' art.

Music is sharply differentiated also from poetry and from literature in general because it does not depend on the use of human language. While music in the course of its history has developed conventions and notations, so that it is not unusual to speak of the language of music when referring to musical form and even, to a certain extent, when discussing the 'content' of music, yet musical expression is a very different matter from the use of natural languages in speaking, listening, reading and writing. The use of language would be impossible without some fairly widespread agreement about the nature of our perceptions of the external world and about the ways in which we reason on the basis of those perceptions. The conventions and constraints which link words with 'reality' and thus form the foundation for the use of natural languages have no parallel in music and there is a sense in which music is quite free from such requirements. It presupposes very little more than that most human beings have some physiological functioning which we call hearing and that this can be affected by a very wide range of different sound effects. We are obliged to accept that there is some activity possible for the human being which we may call musical thought, but we have no means of predicting or even stating how such 'thought' is related to the sounds of music.The existence of this mental activity does incidentally present something of a challenge to the 'linguistic' philosophers who have for a long time been trying to

persuade others, or perhaps it is only to convince themselves, that words and thoughts are identities and that there is no thinking which is not simply operating with language.

The feature which is most specific to music, however, is that it is an activity which is linked with time in a special way because it reaches us through the sense of hearing. The patterns of music are necessarily spread out in time while visible patterns are displayed in space and can therefore be taken in at one time. This does not mean that in music, and in auditory things generally, events that take place simultaneously are not important. In fact one object of this lecture is to show that music does produce effects by feeding us stimuli through many channels at one time. But the hearing mechanism, by its very nature, is time dependent in a way in which vision is not. One consequence of this, as we shall see later on, is that music can make use of a number of different time scales in weaving the threads that make up its complex patterns, focusing our attention now on one thread, now on another or influencing us in a variety of ways by the subtle interaction of its diverse strands.

The effects of music as recorded in legends and stories cover a wide range, from the enchantments of Orpheus 'with his lute', through the destruction of the walls of Jericho to the much more recondite influences known to Saadi, El Ghazali, Rumi, Chishti and many others. Here we shall be concerned only with what Western science can discover about the effects of music on the individual human being.

If we listen to any wide range of Western music, we can see at once that there are three basic directions in which the effect of music is felt. Anthony Hopkins, whom many of you will have heard 'talking about music', has expressed this very graphically by saying that some music is aimed at your feet, some at your head and some at your heart. In most of the music that is familiar to us the three elements are of course combined to some degree, but the balance between them changes frequently and it is almost invariably the case that one of the three is predominant. The classical symphony is a good illustration of this fact. The usual first movement, with its 'sonata form', is fully effective only if the structure is followed with the head. The slow movement which generally follows has a largely emotional effect and the third movement, minuet or scherzo, is explicitly called by a dance name. The last movement takes a variety of forms and quite often provides a balance between all three effects, a combination of the elements. The rondo, for example, which was a favourite last movement form with classical composers, stresses the structure by the repeated return to the first and principal theme; at the

same time it usually depends on well-marked ‘tunes’ and is generally strongly rhythmical.

It is not at all surprising that a musical form which so effectively exploits the multi-channel nature of music as does the symphony should have survived for so long. Examples of the contrasting types of music in successive symphonic movements are to be found in all the classical and romantic composers, from Haydn and Mozart through Beethoven and Schubert down to Brahms, Dvorák, Tchaikovsky and Elgar. A single work which we might take as an example is Beethoven’s Second Symphony in D Major. The first movement is built on a series of subjects, themes or ‘ideas’ which could not really be called tunes; their appropriateness for the purpose resides in the fact that they are eminently suitable for transforming and modifying in the course of the development section of the movement, that is to say that they are generally short, they have well-marked features of rhythm and melody and remain easily recognizable through the changes they undergo, thus giving the ear and the brain a good chance of following the musical form. With the second movement, a complete change comes over the atmosphere, produced by a long, broaď, sustained tune. The third movement is a scherzo, in which the listener is predominantly aware of the rhythm, and in the fourth movement we come back to the well-characterised tunes or themes which draw our attention to the musical shape of the movement.[1]

On the basis of this example, we can be more specific with respect to the three principal effects of music: the appeal to the intellect lies mainly in the musical form; the element which makes people want to dance is the rhythm and the emotional effects come through the melody and the harmony. Naturally it is impossible to think of any piece of music which does not embody all three, but each element has its own time scale and in fact the time spans which are involved do not overlap with each other. Musical form, which employs the most extended time scale, depends on times which are always greater than the longest pulse in a rhythmic pattern; the shortest rhythmic beat is longer than the period of any of the vibrations which are the basis of melody and harmony. It is not difficult to see, in principle at least, that the human organism may well contain receptors tuned to these different ranges, and indeed to others about which science as yet knows nothing. Viewed in this light, music certainly constitutes a multi-channel input to the human being and in this no doubt lies some of the power which it exerts over a large part of mankind.

The Time Scale of Musical Form

We will now look in more detail at the three time scales associated with form, rhythm and melody, to see what the limits are likely to be in each case and what can be said about their effects. Form, rhythm and melody clearly constitute something of a Chinese box arrangement – the form is itself made up of elements which will be rhythmic and melodic patterns; a rhythm is an array in time of sounds which will have some pitch or other and so be melodic elements. Melody and harmony both depend on the perception of pitch, which is the effect of rapidly repeated pulses arriving at our ears. In each of the three spheres the essential feature is repetition, or rather the recognition of something repeated on the part of the listener, so that all three depend upon the use of memory. The difference between them lies in the time interval for which things have to be stored or after which they must be recalled in order to make their effect.

It should perhaps be pointed out that this kind of recall is not dependent upon the listener's being aware of exactly what he is doing. The great majority of listeners get pleasure and intellectual satisfaction from a fugue, a sonata first movement, a rondo, variations, whatever it may be, without any explicit realization that a certain tune has reappeared, or that it is now in the bass or in a different key, and certainly without mentally writing the label to stick on the particular form they are taking in. The brain contains the mechanisms for recall and recognition without this kind of intervention.

The order of time involved in the appreciation of musical form is generally to be reckoned in minutes, but the possible range is very wide indeed. The first movement of a Haydn or Mozart symphony, for instance, will last perhaps from about six to twelve minutes. In this time the listener is presented with a great deal of material which includes first, the musical ideas of the movement in their basic form in the exposition section (and this is often repeated so that the listener may become more familiar with them), then with a number of transformations of these ideas, both melodic and harmonic, and finally with the recapitulation of them, all the various sections being joined together by linking passages. It is rather interesting to find that when we come to later composers, Beethoven, Schubert, Brahms and Dvorák there is no striking increase in the time devoted to such a first movement, even though the working out of the musical material may become more complex. Even in Schubert's 'Great' C Major Symphony, which has the usual four movements and takes in all about fifty minutes to perform, the first movement accounts for no more than about thirteen or fourteen minutes. There appears to be some natural

constraint which keeps movements in this 'sonata' form within the range from about five to about fifteen minutes.

First movement form is itself a quite sophisticated musical construction and one which makes considerable demands on the attention of the listener. There are obviously much simpler forms for which the time span is a good deal less. Strophic songs with their repeated verses often consist of just two sections which are repeated for each verse and which occupy no more than a minute or so. It is not easy to set a lower limit on the time scale for taking in musical form. One example given by Scholes[2] is worth quoting; this is a hymn tune composed by Tallis in 1567 which consists of only eight bars and tăkes scarcely half a minute to play. Yet astonishingly this piece contains within itself the complete germ of first movement form; the first two bars present one tune, the next two, a second tune in the key of the dominant; the following two bars are simply a repetition of the first tune and the last two repeat the second tune but now in the tonic key. This scheme is the basic structure of the 'sonata' form which has just been mentioned in connection with the symphony; one could not hope to find it in a more compact form than that of the Tallis hymn.

At the other end of the scale, there are works based on a 'cyclic' form. In this the composer writes subjects, tunes, motifs or even something in the nature of musical mottoes, and these are the germs out of which grow the music of a whole movement or series of movements. In such works, material which is introduced early on will recur transformed in various ways very much later, even at the end of the work, so that the time span involved in the appreciation of the form is even more extended than in the case of the older 'sonata' form.

The extreme of the cyclic form is found in works which are based almost entirely on 'motifs', as are for example the operas of Wagner's *Ring*. In the four operas which make up the cycle, a very large number of 'motifs' is employed and they are used to signal references to characters – Siegfried, Brünnhilde, Gutrune; to objects, such as the ring, the sword, the 'tarnhelm', or to abstractions and emotions like renunciation, atonement, sorrow, compassion and love's redemption. The motifs occur and recur many times during the four operas so that the time scale is basically very long indeed. Listeners do not of course listen to the whole *Ring* cycle in a single session; if they did, they would be exposed to something like seventeen hours of continuous music and this would be roughly the interval between their first hearing of, for example, the Rhinemaidens' motif which opens the first opera and the last hearing of it at the very end of the last opera, truly an extreme example of the cyclic form.

The appreciation of musical form then requires the continual exercise of memory and recall over periods that have to be counted in minutes, if not hours. This is very much an intellectual operation and it is natural that its effect should consist in the intellectual pleasure or satisfaction which comes from apprehending patterns and shapes on such an extended time scale.

The Time Scale of Musical Rhythms

Let us turn now to musical rhythm. Like musical form, rhythm depends on the recurrence of events in time, but a move from the sphere of form to that of rhythm entails a large step down in the time scale. Musical rhythm is based on the recurrence of beats in the musical bar and on sub-divisions of these beats, the actual time intervals being determined by the tempo or speed of the music. The whole range of variation in the fall of the rhythmic beats lies within a span from about one-tenth of a second up to about one and a half seconds. This time span in itself suggests one reason why it is the rhythmic side of music that makes listeners feel the need to dance or to join in the music with movements; these times are very much those involved in the physiological rhythms of the human body. At one end of the scale, the alpha rhythm of the brain is the periodic fluctuation in its electrical potential which is associated with the human being's scanning of his environment. The period of these fluctuations is about one-tenth of a second. Next in frequency comes the average pulse rate which is 72 pulses per minute, giving a period of five-sixths of a second and last, the rate of repetition in quiet breathing which is somewhere about 18 breaths per minute, that is a period of just over three seconds. We might add to this the rates at which voluntary muscle movements can be repeated, which is with time intervals somewhere near one-tenth of a second. All these values cover a range which coincides quite closely with the times involved in musical rhythm patterns and it is therefore not very surprising that rhythm is the aspect of music which produces the most nearly physiological effects. There is clearly a probability that rhythmic beats may tend to 'lock in', as it were, with pulse rate, respiration rate and neural and muscular mechanisms.

Perception of rhythmic patterns is much more direct than that of form and the only type of memory involved is short-term memory. The time intervals just indicated refer simply to successive beats and it will generally take several such repetitions to make a pattern; even so, the total time is short enough to be dealt with in short-term memory. Much of the effect of rhythm is produced by setting up a strong expectation in the

listener; that is to say that when a few beats have fallen at regular intervals, our physiology anticipates that the regularity is going to continue and that further beats will fall. Musical rhythm exploits not only this anticipation but also the disappointing of our expectations and the setting up of ambiguities and irregularities which contrast with a scheme of regular beats. So on the one hand we find the exhilarating effect of regularly and rapidly repeated notes like those, for example, of the brass in the second movement of Borodin's Second Symphony in B Minor[3] or again, the almost hypnotic effect of the slower repeated drum beats, five to every bar, in a section of the second movement of Tchaikovsky's 'Pathétique' Symphony[4].

There are, on the other hand, a variety of ways in which the rhythm can be 'broken' and the expectation kept in some kind of suspense. In the Scherzo of Beethoven's Second Symphony, already referred to, the regular three beats to a bar are shared out between different sections of the orchestra and between forte and piano so that the listener feels himself compelled to keep the rhythm going with mental beats. In the second section of the same movement, we find the rhythm broken by a cross-rhythm in which the accent falls, not in its usual place on the first beat of the bar, but on the second beat, producing a syncopated effect.

Cross-rhythms are a device favoured by many composers and nearly always have the effect of involving the listener more deeply in the rhythmic movement of the music because they force him to be aware of the regularity from which the pattern represents a departure. Sometimes this departure is quite momentary, as it is in the third movement of Beethoven's 'Eroica' Symphony; after more than one hundred bars of a regular three beats to a bar with the stress on the first, the accent is suddenly shifted on to the second beat, then to the third over a span of four bars and this device is repeated four bars later. After this the rhythm returns to the regular scheme, but the effect of the interruption is quite electrifying.[5]

In other cases the composer maintains an impression of ambiguity for some long time during which the listener is kept as it were suspended between the basic rhythm and the superficial one. An example of this kind occurs in the fourth movement of Brahms' String Quartet in A Minor, where the three beat rhythm of the time signature does not establish itself explicitly until after twenty-four bars have passed[6].

It is in part rhythmic ambiguity which lends a special character to some Spanish music. One of the commonest devices is the one in which rhythms of three crotchets and six quavers alternate, that is a strong beat of three

followed by a beat of two which fills the same length of time. Another variation is the group of three beats followed by two beats, where the length of the beats remains constant, or again an accompaniment with a marked three beat rhythm over which is placed a tune in two beat rhythm. The first of these variations is found in French and Rumanian folk music as well as in Spanish; an example of the second is heard in Bizet's Entr'acte before the last act of *Carmen*. Much more intricate rhythms are to be found in genuine Spanish music, and in great variety, but then a large proportion of this music is in fact music for dancing so that it is understandable that rhythm should play a dominant role.

The effect of rhythm and particularly the balance between rhythm and melody is very much bound up with the tempo of the music. If the rhythm is to make the predominant impression, the beats have to fall in fairly quick succession; if the interval between beats is long, then it is the melody which makes the greater impression on the listener. Of the whole range of time intervals available for rhythmic patterns, it is the upper part, that is the range with shorter time intervals and more rapid beats, that must be used if the music is to be strongly rhythmical in character. Conversely, if the melody is to be dominant, the tempo and the fall of the beats must not be too rapid. We have already seen one example of this in the contrast between the second and third movements of Beethoven's Second Symphony. There are others in which the same 'tune' appears both fast and slow and where it becomes quite evident that the balance between melody and rhythm swings as the tempo is changed. One well-known instance is the opening of César Franck's Symphony in D Minor and another, less familiar to most listeners, occurs at the beginning of Dvorák's Third Slavonic Rhapsody in A Flat. Here the main tune of the piece is first played slowly on the harp and one is aware only of the broad lines of the melody, but the slow introduction is followed by a quick section in which the same tune now figures as a lively dance movement[7].

In by far the greater part of Western music, of course, there is some degree of balance between rhythm and melody, so that in music that is familiar to us we remember both a characteristic rhythm and a characteristic melody. However, if we take away the rhythmic pattern, by playing a succession of completely even and unaccentuated notes, the best known tunes become almost unrecognizable whilst we can still recognize quite a large number of tunes if the appropriate rhythm is tapped out, without the different notes of the tune. Once we have heard a particular tune, reproducing the rhythm is quite a powerful way of recalling that tune to our memory. This is a device which is employed by some composers,

particularly where they are making use of the 'variation' form. Beethoven and Schubert and, to an even greater extent, Brahms, especially in his chamber works, employ rhythmic patterns in this way.

The Time Scale of Melody and Harmony

Form and rhythm constitute two channels through which the influence of music reaches the listener. What remains is the realm of melody and harmony and these produce even more powerful effects, partly because they work directly on our emotions and partly because they form, not one or two more channels simply, but a whole complex of paths by which stimuli reach the listener.

The appreciation of both melody and harmony depends on our sense of pitch; consequently the time scale is determined by the periods of time intervals associated with this sensation of pitch. The ear and brain perceive a sound as having a certain pitch if the vibrations arrive regularly with an interval no greater than about one-thirtieth of a secoňd. When it is longer, the ear hears a succession of noises with gaps between them rather than a musical note with a definite pitch. This is the lower limit for pitch. At the other end of the scale, a vibration with a period of about one-twenty-thousandth of a second will be heard as a pitch. In fact this is true only for a fairly young person; as we grow older, this limit drops to the region of one-sixteen-, one-twelve- or one-ten-thousandth of a second. Because these times are so short, it is more convenient and more usual when talking about pitch, to refer to the number of vibrations or cycles per second as a way of showing the time interval concerned. In these terms, the limits for our perception of pitch can be set as from 30 cps up to about 15,000 cps. Just in order to associate this range with the ordinary musical notation, the frequencies for notes on a seven-octave piano can be taken to be: for the lowest note, the bottom A, 28 cps; for middle C, 261 cps; for the equivalent of the orchestral A, 440 cps, and for the top A, 3520 cps. It should be noticed that the human ear and brain is so organised that every rise of one octave in pitch requires a doubling of the number of cycles per second. This means that if we continue the range upwards from the top note of the piano (3520 cps), an extension of only two octaves would bring us to a frequency of 14,000 cps, that is very near the upper limit of the ear.

It seems intuitively reasonable that if music makes an appeal to our emotions, and common experience leaves little doubt on this point, it should be largely through the most rapid and, in this sense, most intense vibrations. Both melody and harmony operate within the same range of frequencies and, in Western music, both contribute to the emotional effect.

Of the two elements, melody is the more dynamic because its effects depend on the sequence of pitches while harmony is the more static, depending on the relations of pitches which are sounding at the same time. Historically, harmony developed much later than melody in Western music and the appeal of melody is in any case somewhat more primitive. The basic mechanism at work in melody is quite simply that progressive rises in pitch raise the emotional tension in the listener and a fall in pitch relaxes the tension. From this simple principle come all the diverse emotional effects which melodies produce through combining the direction of pitch change with the distance through which it changes and the rapidity with which the change is made. Naturally all tunes will include both rising and falling phrases so that their character depends on whether the rising or the falling phrases predominate. If the first is the case, i.e. if rising phrases predominate, then the music is likely to evoke feelings of cheerfulness, joy, triumph and the like; if the second, the emotional colouring will be that of sadness, melancholy, despair or nostalgia. To take just one example of each, there is a strong contrast between the third movement of Beethoven's Seventh Symphony, with its invincible cheerfulness and the second movement of Brahms' Second Symphony, which gives an impression of gravity, if not of melancholy. The difference is to be accounted for much more by the rising phrases of the first and the descending phrases of the second, than by the mere difference of tempo[8].

One of the most unequivocally nostalgic tunes in all the musical literature is contained in the slow movement of Dvorák's 'New World' Symphony and it is interesting to see that while the melody includes many rises in pitch, the function of each rise is to provide the space for a falling phrase. The scheme therefore is an alternation of a step up in pitch and a gradually falling succession of notes; it is the latter phrases which give the overwhelmingly melancholy character to the music.

In much of Western music, melodies are strongly linked to the diatonic scale, and hence to the harmony. The character of the rising and falling phrases is affected by the particular degrees of the scale which are involved; the tonic, the doh of the scale, always represents an anchor point to which the tune is going eventually to return. Other points on the scale serve to increase the emotional tension as they are used to hold off the approach to the tonic. There is an extreme example of the use of the leading note, the seventh note of the scale, to be heard in a composition of Duke Ellington, 'Star Crossed Lovers', where the performer often plays and sustains the note so close in pitch to the key note as to produce an

extreme effect on the nerves of the listener.

Many melodic effects depend therefore not only on the rising or falling line of the phrase, but on the particular notes of the scale involved and on the size of any leaps, either up or down, that may occur in the melody. A sudden leap upwards is most likely to produce an impression of agitation of one kind or another, while a sudden drop to a much lower note will introduce a rather extreme relaxation of tension, very different from that which the listener feels in the gradually descending phrase. Sudden leaps and drops in the melody are rather characteristic of certain composers, one of whom is Elgar. In the second movement of his 'Cello Concerto, for example, there is a section in which a degree of agitation is generated rhythmically by rapidly repeated notes and the agitation is resolved melodically by an extended phrase with a succession of drops in pitch, the largest of them being a seventh. The slow movement of the same work is based on a broad tune in which Elgar uses very wide melodic intervals, both rising and falling, to create a sustained and very powerful emotional effect.

A notable example of the effect of a leap upward is to be found in the last scene of Verdi's opera *Otello*, when Desdemona says good-night to her maid, Emilia, and then has a sudden presentiment of her own fate. Her extreme agitation is given expression in a leap in the voice part to a note one octave and a third above the previous note she has sung; the effect on the listener is due, not simply to the sudden loud, high note, but to the interval which it represents from the previous sung phrase.[9]

The emotional effects produced by melody are often reinforced and underlined by the harmonies that go with the tune. There is of course the commonly recognized contrast between a minor and a major harmony, which is broadly a distinction between the melancholy and the cheerful, though this difference is usually also present in the melody, which is based on different scales in the two cases. The effect of the progression of chords, like that of the melodic progression, depends very much on the relation of the chords to that of the key-note. The chord of the doh of the key represents the final point of repose to which the harmony eventually tends, while other chords will convey that this final relaxation of tension is either further off or coming nearer, they will either temporarily increase or decrease the suspense. In this way the chords used in any harmonic sequence can be graded, some of them denoting that the 'return home' is near, as it were, others making it clear that such a return will inevitably be long delayed. Among the latter are all the harmonies which are quite evidently discords or dissonances; these may serve to arouse the listener's

attention or even his apprehension and they usually show that much has still to be experienced before the music reaches the repose of the final cadence of the piece. One of the most famous of such dissonances is that which introduces the last movement of Beethoven's Choral Symphony. When on the other hand the composer intends to bring a movement or a section to a close, he will often make use of a series of concords, some of which may serve the purpose of postponing the return to the key-note, but the general trend of which will be towards the final relaxation of emotional tension. In some of Beethoven's works this 'approach to home' may be very much prolonged, as it is for example at the end of his Eighth Symphony. In other cases the matter is dealt with in the shortest possible way, as it is for example at the end of Sibelius' Seventh Symphony, where the final resolution can only be described as being laconic.

When talking about rhythm, we noted that rhythm can be used to set up and maintain a feeling of ambiguity in the listener, to keep him suspended between two solutions for a time. Similarly on its own level, harmony can be employed in the same kind of way. The commonest instance of this is the oscillation between major and minor harmonies, but it is also done in many subtle and complex ways by modulating away from the original key of the music and back again. Schubert is a composer to whom this particular device appealed very strongly and one finds examples of its use over and over again in his songs. A particularly remarkable and prolonged example occurs in his song called *Im Frühling*[10].

The Effects of Sound Quality and Timbre

In dealing with musical form, rhythm, melody and harmony we have considered all the aspects of music that are represented on the printed page except for contrasts of loud and soft, and the particular instruments on which the music is to be played. Loudness clearly contributes much to the effect of music, but it is very much bound up with rhythm and melody and does not operate on its own time scale, so it will not be discussed separately here. The instrument which plays the music, and more generally the quality or timbre of the sound, is an important factor and one which falls within the range we have been considering.

A composer writing an orchestral piece will indicate that certain parts of the melody, certain notes in the harmony are to be played by this or that instrument and in this way settles the 'colour' of the resulting sounds. This element obviously plays an important part in the effect of the music; where, in terms of the time scales we have been looking at, does it operate? The answer to this question is that, just as in harmony a chord is

produced by sounding several notes at the same time, so one instrument, sounding a single note, is in effect producing a chord made up of the various overtones or harmonics which the instrument generates. Harmonically one might, for example, play several chords in which Middle C was the lowest note; these might consist of the notes C, E, G, or C, F, A, or C, E flat, G, or C, E, G, B flat, and so on. In each case the chord would sound different. If we now hear just the one note, Middle C, played first by an oboe, second by a clarinet, third by a trumpet, fourth by a violin and so on, it is evident that each of these notes sounds different. Each instrument when playing a single note produces a range of overtones or harmonics, some stronger and some weaker, some reaching high up into the frequency range and others confined to the lower part. The difference between the individual instruments lies in the 'mixture' of overtones characteristic of each one. For example, if we compare the oboe and the clarinet playing the same note, we should generally judge that the sound of the oboe is sharper or more 'squeaky' while that of the clarinet is rounder. This is accounted for by the mixture of overtones in the two cases: the oboe when playing Middle C gives rise to overtones in the region of 7000-8000 cps. which are four times as strong as the lowest note in the mixture (Middle C itself). Although in the clarinet there may be some overtones in the same region, they are very much weaker than the lowest or fundamental tone and so the tone colour is dominated by the lower harmonics in the mixture.

The colour or timbre which is characteristic of a given instrument, then, is the result of concentrations of acoustic energy within a certain frequency region or regions. A flute, a viola, a bassoon or a French horn each remains recognizably itself even when playing different notes because of these concentrations of energy. There is however some variation of colour possible in a given instrument; it will change to some extent when the player is playing high notes or low notes, loud or soft or when he adopts different techniques for producing the notes. If a violinist, for instance, bows his strings near to the bridge of the instrument, he will produce a sound which is not only louder but richer in high harmonics and therefore brighter sounding; if he bows further away from the bridge, these higher harmonics will be much reduced and the colour will be muted, more 'breathy' and softer. Players of wind instruments, too, have some variations of colour at their command: French horn players, for example, are sometimes instructed by a composer to blow a particularly 'brassy' sound (cuivré), in which the higher harmonics are reinforced. Even so, the orchestral instruments are comparatively limited in the range of colours available to them.

This limitation does not apply to the human voice, and among the possibilities open to a composer we must include the variations in colour which it offers. The frequencies of the harmonics or overtones we have been speaking about lie within the range already noted as producing emotional effects and in general the function of tone colour is to enhance the emotional impact of the music; it adds as it were another dimension to the effect of melody and harmony. From this point of view, the human voice occupies a special position, as we can readily appreciate if we think for a moment about the way in which people use their voice in everyday life. We are all very practiced in recognizing the mood of a speaker from his 'tone of voice'. We know that this changes according as the person concerned is feeling sad, joyful, angry, tender, agitated and so on. The accomplished actor is able to produce these effects at will and the same possibilities are open to the practiced singer. In both speech and singing, the changes in colour are again brought about by varying the strength of the harmonics in different parts of the frequency range. Although it is possible to state one or two general principles in this connection, we do not as yet have any very detailed information about the relations between the expression of emotions and the acoustics of the voice or about the ways in which the effects are actually produced by the singer or speaker.

In the case of the orchestral instruments, we have seen that variation in timbre is limited in one instrument so that composers achieve variety by very complex combinations of instruments. It is perhaps not very profitable to make generalisations about the emotional effects of these variations but broadly speaking, when the tone is rich in the higher harmonics, the effect will be one of brightness, cheerfulness or, in certain contexts, of aggressiveness; when there is a preponderance of lower harmonics, the mood will be more one of sadness, contemplation or tranquillity. Between these extremes lies a whole gamut of emotional impressions which have been exploited very fully by composers over the centuries.

The human voice is unique in that it is capable of much greater variations in colour than any one instrument; it is as though the singer had at his disposal a range of instruments from which he may select and he can therefore obtain effects of correspondingly greater subtlety and complexity. Each individual singer sings, of course, with his own voice; that is, there is a tone colour which is characteristic of him or her personally and on this basis the variations required for performance are built. Depicting differences of mood rests largely on the mixing of what one might call three primary colours. When the tone is rich in harmonics

in the middle part of the frequency range, we have a colour which is appropriate to the expression of joy and gladness; if the lower harmonics are emphasized at the expense of those in the middle range, then we have an expression of awe and reverence; if there is a concentration on the higher harmonics and a corresponding reduction in the middle and lower ones, then we have the expression of anger or aggression. The mixing of these three effects in varying proportions affords a wide range of possibilities for the expressing of an emotional mood. The middle range of harmonics is extended towards the upper end if the mood of joy is to be tinged with cheerfulness, light-heartedness or triumph, or it will be extended towards the lower end if it embodies also thankfulness for deliverance; if only the very lowest harmonics are emphasized, the mood of awe is changed to one of fear; a mood of disgust or disdain might call for the high harmonics mixed with the lowest ones, and so on.

The really accomplished singer, and certainly anyone who is in the first rank, has all these means for the expression of emotion at his disposal, though of course he is unlikely to be analytical about the matter. He will be able to reinforce certain ranges of harmonics at will, without necessarily being aware that this is the method by which he achieves the results he wants. Whether he is singing songs or performing an operatic role, he is all the time playing, as it were, another tune of emotional expression above the more obvious tune of the melody and the rhythm. It is this quality which listeners recognize when they hear a 'great' performance from a singer, and it is the quality which they sometimes miss when listening to what is without doubt a beautiful voice giving a performance which the listener feels to be uninteresting.

A variety of possible effects and the enormous wealth of examples in the musical and especially the operatic literature make it scarcely possible to select instances for quotation. Verdi in particular was a composer who was above all concerned with the variety of human emotion and the means of expressing it, so that almost any solo aria from one of his operas will supply clear-cut examples. In *Un Ballo in Maschera*, for example, Renato believes that he has discovered, though he is in fact mistaken, that his wife has been unfaithful to him with his master, the Duke, and in the aria 'Eri tu', he expresses both his rage against his master and his sorrow and regret at the memory of former happiness. In a good performance of this aria, one hears the definite changes of vocal colour which express the alternation of the moods, reinforcing and enhancing the emotional effect of the melody which uses repeated notes and strongly rising phrases in the one case and nostalgic falling phrases in the other.

Even the practiced listener is generally very little aware of the means by which emotional impressions are conveyed to him by the singer and certainly has no idea how far the first-rate performer may go in the direction of 'playing tunes on the harmonics'. A most interesting and impressive example of this can be heard in the recording by Gigli of the two arias from Mozart's *Don Giovanni*. The aria 'Il mio tesoro' is one in which the melody is full of movement and activity, rising and falling phrases and rapid scale passages expressive of active devotion and readiness to spring to the defence of the lady concerned. The other aria, 'Dalla sua pace', in the first section at least, is an expression of devotion of another kind, expressing sympathy but quiet, reflective and almost static in character. In singing these arias, Gigli produces two remarkable effects by the selection of harmonics. In the first, he places over the top of the melody, for much of the time, a single prominent harmonic which rings out through whole long phrases, like an affirmation of constancy accompanying the readiness for action. The melody of the other aria itself expresses repose, certainty and stability, and here in the harmonics Gigli reverses the process, at each phrase or part of a phrase selecting a different harmonic, producing a kind of arpeggio on the harmonics which complements with movement and variety the rather static character of the melody[11].

It is naturally difficult for the average listener to detect the presence of particular harmonics or of a specific range of harmonics in the singer's tone, but it is possible by the use of electronic filter circuits to isolate and make audible any desired frequency range. In this way we can, as it were, open a window on a part of the tone and so make given harmonics quite obvious. When this is done with the Gigli records so as to reveal the harmonics between 2200 and 3000 cps., for example, the effects that have just been mentioned become apparent.

It was said at the beginning of this lecture that the information we have in the West about the effects of music is very incomplete; this account of some of them cannot in any case be more than a brief indication of a few interesting facts that have come to light, but perhaps it will serve to show directions in which it may be profitable to explore. One thing which is beyond doubt is that music does constitute a multi-channel input to the human being; all the time we are listening we may well be taking in the musical form by way of the intellect, the rhythm through the body more directly, and the melody, harmony and tone colour through our emotional receptors. We can certainly say that 'if music be the food of love', it is also the food of many other things in the human being at the same time.

Notes

1. The lecture was illustrated by playing excerpts from a number of the musical works mentioned. The following passages were played at this point: Beethoven, Second Symphony in D Major, First Movement, Bars 34-72, Second Movement, Bar 1-16, Third Movement, Bars 1-16, Fourth Movement, Bars 1-25.
2. See Scholes, P., *Oxford Companion to Music*, 1st Edn., p.334. The hymn was recorded for use as an illustration.
3. Borodin, Symphony No. 2 in B Minor, Second Movement, Bars 1-55.
4. Tchaikovsky, Symphony No. 6 in B Minor ('Pathetique'), Second Movement, Bars 57-80.
5. Beethoven, Symphony No. 3 in E Flat ('Eroica'), Third Movement, Bars 76-143.
6. Brahms, Quartet in A Minor, Op. 59, No. 2, Fourth Movement, Bars 1-32.
7. Dvorák, Slavonic Rhapsody, Op. 45, No. 3 in A Flat, Bars 1-11 and Bars 41-67.
8. Beethoven, Seventh Symphony in A Major, Third Movement, Bars 1-24, and Brahms, Second Symphony in D Major, Second Movement, Bars 1-32.
9. Verdi, *Otello*, Act IV, Scene 1, Bars 211-248.
10. Schubert, *Im Frühling*, Bars 4-16.
11. Mozart, Arias 'Il mio tesoro' and 'Dalla sua pace' from *Don Giovanni*, recorded by Gigli, Bars 8-29 and Bars 1-16. The full range recording was followed by a recording made with a band-pass filter with the limits set at 2200 cps and 3000 cps.