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SCIENCE AND SINGING.

BY

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"MEDICAL HINTS ON PRODUCTION AND MANAGEMENT OF THE SINGING VOICE."

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PREFACE.

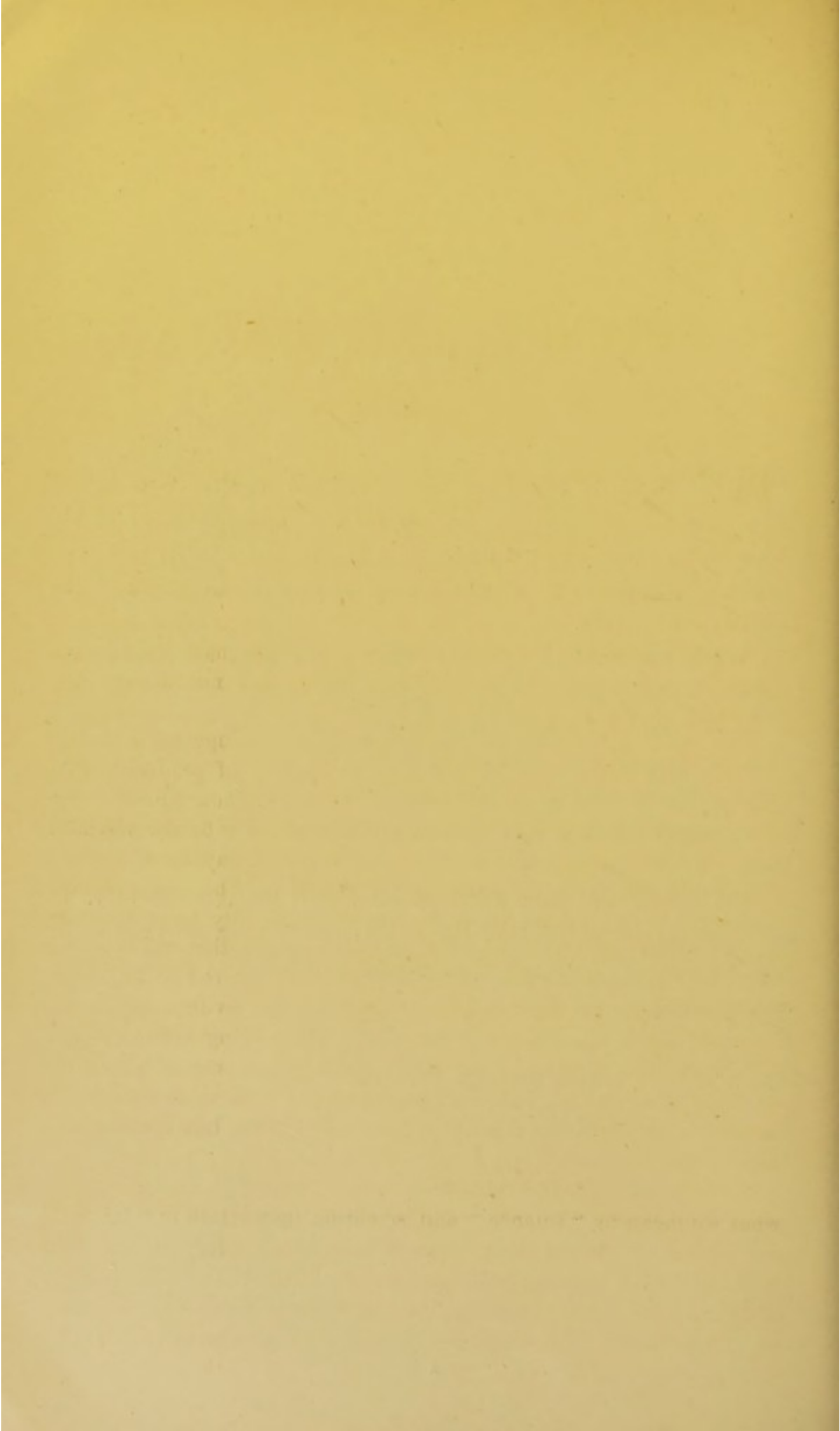
THIS Essay is based on the shorthand report of a lecture recently given at the Society for the Encouragement of the Fine Arts (Mr. Alfred Gilbert, R.A.M., in the Chair), and it is printed in response to a very general request by members of the Society and others.

While the form of personal delivery has been maintained, the matter has undergone various modifications. Some subjects, deemed to be of rather ephemeral interest, are now treated with less detail than in the original discourse; others of more importance are proportionately amplified; and, finally, some points which could not be even mentioned in one lecture are now considered for the first time.

The author will have achieved his aim if his remarks serve to secure wider appreciation of the advantages of scientific method, in relation to voice production, as a sure foundation of good singing and speaking.

36, WEYMOUTH STREET, PORTLAND PLACE, W.

April, 1884.



SCIENCE AND SINGING.



WHEN requested last October by the Chairman of the Council of this Society to deliver a lecture during the session, I gave the subject some deliberation before consenting, and ultimately came to the conclusion that it might be in my power to give "encouragement to the fine art" of singing by offering you a few illustrations of the power of Science to aid its cultivation, and to say a few words of warning as to the too ready acceptance of what may, from time to time, be proclaimed as science, but which will not always bear scientific investigation.

As most of you are aware, my profession brings me into daily relation with singers and speakers, not in the way of producing their voices, but for the purpose of repairing them when out of order. Each successive year that I practise, I am the more firmly convinced that whatever constitutional predisposing cause may exist, however reasonable the cause assigned for the effect may be,—and patients always do assign a cause, such as a cold, an unduly large building, a trying opera, or what not,—I almost always find that the true first cause is some fault in method. Science has been ignored or disobeyed, and punishment has followed, with more or less swift steps, in the shape of vocal impairment or disability. This being acknowledged, it follows that, if science can point out a better way of doing the work, in other words, with more precision and with more economy of force, not only will the executant results be better, but break-downs will be less frequent.

It will be as well to pause here for a moment, and agree as to what we mean by "science" and scientific instruction in relation to our subject. I do not think I can do better than refer you for a good working definition to an admirable lecture given lately at the Society of Arts by Mr. Lant Carpenter (the son of the celebrated physiologist, Dr. Carpenter), "On Scientific Training in Elementary Schools."

He first spoke of it as "that orderly arrangements of facts, to which in a broad sense we give the name of science, or the scientific method which may be, often is, and still more often ought to be, applied to the treatment of all subjects of instruction," for, as he said, "a lesson on an air-pump may be thoroughly unscientific, while a lesson on the infinitive mood may be scientific in a high degree." Paraphrasing Mr. Carpenter's further remarks for our present purpose, I wish to be understood this evening as meaning by Science, in its bearing on Singing, that knowledge of facts and phenomena of the universe of song, with which every singer or speaker is in daily relation, though too few of them realise it. The particular scientific methods of value for attaining knowledge of such facts and phenomena are those of experiment and observation.

As to the necessity for this knowledge, let me draw your attention to a recent notice of a book of which I am joint author, in *Knowledge* (Feb. 8, 1884).

The review says: "Though scarce one person in a hundred can use his voice either in speech or song as it might be used, though hundreds lose their voices, or all the beauty from their voices, long before advancing years might fairly be expected to rob the vocal organs of their power, yet scarcely any seem to learn the lesson so often taught, or to note the warning thus often conveyed. Such a work as the present, therefore, is much needed, and deserves the careful attention, not of those only who have to employ the voice professionally, whether in singing or speaking, but of all who care for the voice. We may apply specifically to this case the general saying of the great teacher of our age. 'If any one doubts,' says Herbert Spencer, 'the importance of an acquaintance with the principles of physiology as a means to complete living, let him look around and see how many men and women he can find in middle or later life who are thoroughly well.' If any doubt the importance of knowledge respecting the principles of vocal utterance and vocal culture, let him consider how few men and women in middle or later life (I would say at any age) have the thorough command of their vocal organs." Let me ask in addition, and with all deference, how many teachers can give a scientific—that is an accurate—answer to a pupil in explanation of the simplest physiological problem connected with singing, or any but an empirical reason for the modicum of vocal faith of which they may be possessed?

One word or two in illustration of the errors often made for want

of scientific knowledge, in explanation of instructions which may practically be correct. A very eminent teacher in Milan is reported to say to his pupils: "Breathe through your bones, inflate your bones." Again, I recently saw a letter from another teacher of singing, in which he wrote to a lady, "Although for ordinary purposes people breathe with their lungs, for singing purposes you must breathe with your stomach." Now, both these people had an inkling of a physiological fact, but they had not that scientific accuracy of knowledge which would enable them to explain it properly. When the one said, "Inflate your bones and breathe through your bones," he intended to say, "Fill your lungs, by expanding your chest walls and feel your ribs pressed outwards;" and when the other said, "Breathe with your stomach," he probably meant, "Let your midriff descend, and let the walls of the abdomen be also pushed forward." Yet another instance of a common failure in exactitude. Not long ago, I listened to a teacher, who, in giving me a notion of his initial lecture, intended to be a physiological exposition of the voice in relation to singing, constantly apologised by saying, "You know, I am quite aware that so-and-so is not exactly the way Nature works, but it is quite near enough for a pupil." I could not help remarking, "What a pity it was that, with such a real aptitude as he possessed for education, he did not teach accurately; for, as is well known, pupils seldom remember all they are taught, and unfortunately, in such a case, they but too often remember only the wrong or the unimportant, and forget what is right and important."

The foregoing instances, occurring in my own experience, of error and inexactitude on the part of teachers of singing, pale in absurdity before some examples committed to print. The authors of such productions are not infrequently clergymen, and their mistakes illustrate strikingly the necessity for teaching vocal physiology in our universities and theological colleges. Three or four years ago I had occasion to allude to one such work, in which the author advised, amongst other directions astoundingly inconsistent with physiology, that we should "never think of propelling the air by any other means than the lungs," for the purpose of tone production, as if air could be propelled from any organ but the lungs. In this work the practical portion was equally unsound, and even dangerous, as was its theory. I have, however, recently seen another book, also by a clergyman, which contains much that is excellent from a practical point of view; and it is therefore all the more to be lamented that the author's notion

of vocal physiology should be so faulty as probably to prejudice many who would otherwise be glad to recommend it. I give three instances, but make no attempt to explain what the author means ; for, in truth, I am unable to perceive any guide to a correct deduction.

The first explains chest voice thus :—“ In a general way, however, we may say that for the *voce di petto*, which requires the vocal cords to be widely separated, and a large volume of air to be poured through them from the trachea (which then assumes its widest dimensions), it is necessary that a corresponding wideness of aperture be secured to the glottis.”

Secondly, for the cure of throaty tone :—“ If the pupil find any difficulty in effecting this ‘ring’ upon the soft palate, then let the vocal stream be aimed, as it were, first at that arch which is formed by the right tonsil and the uvula ; begin the note softly, and coax it out till the note rings again. Next go through the same process with the left arch ; and, lastly, aim at both arches at once, always recollecting to commence the note softly, and never to force it.”

Our last extract is at least equally ludicrous :—“ Drag the larynx well down into the chest ; open the glottis, and expand the trachea to its widest extent.” In making these quotations, I hope I shall be absolved from any desire or intention to cast ridicule, for the mere sake of mockery, on authors desirous of aiding a useful work.

With such a knowledge of the present condition of things and a conviction that a remedy may be found in the promulgation of more accurate instruction, it has been a great grief to me, and to my friend and co-author, Mr. Behnke, that quite recently a different tone has been taken ; the more so because it has emanated from those who, being members of a scientific profession, ought, as we think, to know better. Instead of recognising that voice-preservation, equally with health-preservation, depends on the strictest obedience to nature’s laws, they have said that there is no occasion for the voice-user to study science ; in fact, it has been said by a recent lecturer, “ The more they study vocal physiology, the less they will understand.”

Another has, in a lately published review, written much to the same purpose, backing up his opinion by that falsest of all pleadings, that, because many of the greatest singers have done without scientific teaching, therefore nothing is to be gained from it ; an argument,—or, as one might better call it, an obstruction,—which, needless to say, has been advanced from time immemorial against every act of progress throughout the religious, political, social, or scientific world.

A rather amusing illustration of how opinions may be changed by circumstances is afforded in the fact that, when the laryngoscope was invented, it was prophesied in medical journals that, although an interesting "physiological toy," it was not likely to be of any practical service in the treatment of disease. "Nous avons changé tout cela," and it is now said that, although invaluable for the diagnosis and treatment of laryngeal maladies, the laryngoscope is of no use for investigation of those physiological facts which are probably of chief practical value in relation to the larynx; namely, those which may enlarge our views on voice-production.

It has also been urged that, although these things may be useful or indispensable to the teacher, they are not of the slightest value or use, and may even be harmful, to the pupil. I need hardly reply to such objections; I simply ask, Why should a singer understand singing less because he studies science? Is a gardener a worse gardener because he understands botany? or a painter less successful for a knowledge of anatomy or perspective? or a musician a worse executant for acquaintance with harmony or thorough bass? And why should doctors think that they are to be the sole repositories of vocal physiology, or of any physiology? "It is not the cowl that makes the monk." Some of the best physiologists have not been members of the medical profession. Finally, why should there not be a striving on the part of the pupil to the higher attainment of the teacher, whose place in time he will naturally hope to fill? The suggestion which has been made to me seriously by more than one eminent teaching authority, that scientific instruction should be supplementary, and not preliminary, to practical training, hardly merits an argument for its refutation. Without solid foundation there can be no stability in superstructure.

But I go further: it is a favourite argument that a singer need know no more of the construction and functional powers of his throat than a violinist of the anatomy of the hand, or the ballet-dancer of the anatomy of the leg. Just pointing out, *en passant*, that these two comparisons, so often coupled, are not in themselves equal, except that each is equally fallacious, it is to be noted that if each fiddler could have but one fiddle and could not buy a new one in case of injury, by wrong use or otherwise, of the one in his possession, it would be most important for other considerations than those of pocket that he should thoroughly appreciate every detail of the anatomy of his instrument. But, as to the hand, that is another matter, it being

simply the servant of the musically-educated brain. Quite different also, but equally misleading, is the simile of the limb of the dancer. The excellence of a dancer or of an acrobat is essentially one of muscular agility, acquired almost entirely by imitative practice, and only in the slightest degree co-ordinative with the higher faculties. On the contrary, it is admitted that precision in song depends pre-eminently on prompt and complete co-ordination of the special sense of hearing and other brain qualities with the necessary muscular movements in the larynx, which are followed—so rapidly as to be practically contemporaneous—by like processes influencing alterations in the resonating cavities, and finally by others which convert the produced harmonious and reinforced tone into articulate words.

Those who depreciate examination into the functions of the vocal organ, on the already quoted ground that it is needless for the violinist or ballet-dancer to know aught of the anatomy of hand or foot, will at least admit the value of study with the eye in the case of their prototypes. Careful watching by demonstration and subsequent attempts at imitation as the result of eye testimony of the holding the hand correctly for firm or delicate "bowing" in the one, or of the position of the foot in the other, are perhaps the most practical ways of learning these arts. It is difficult to conceive the idea of a good ballet-dancer who should be blind; and, as far as I know, there is no record of a blind fiddler having risen to the eminence of a Paganini or a Joachim.

Every one admits the important relation of the function of hearing to that of singing; but few, even amongst those who have given some attention to the subject, can have an idea as to the importance of sight in its power to educate the ear. That it has a relation may be proved by a well-known experiment. If a person be blindfold and seated in a chair, and another person make slight noises as of the click of two coins struck one against the other, within a few inches of the subject of experiment, great difficulty will be experienced, and many amusing errors will be committed by the subject in his endeavours to estimate the direction of the induced sound. Sight may even substitute hearing, as illustrated by the fact that speech may be taught by sight to deaf mutes, that is, to persons born deaf, or who have become deaf so early in life as never to have learned language. They can make noise, but they cannot articulate or formulate tone into words.

Carrying this principle into singing education, some teachers tell

pupils to sing before a glass in order to see that they have a pleasant, easy expression of face. Mr. Behnke goes further; he demonstrates to his pupils that, to produce certain vowel-tones with beauty, the alterations in the shape of the articulating cavities must be modified from what they would be for speech; he assists such education of lips, tongue, and of soft palate, not only by demonstration and cultivation of the pupil's imitative faculties, but by recommendation of mirror-practice. Going lower down the throat, the pupil can, by looking in a mirror, see from without whether the movements of elevation and depression of his larynx, in which he may be instructed, are rightly performed, and one has only to carry this idea still further in order to understand how, by means of that wonderful instrument the laryngoscope, observation in the laryngeal mirror of the alterations of the mechanism of the larynx, necessary for production of the primary tones in various registers, will assist the pupil.

I have never previously advanced views so thorough as this as to the importance of laryngoscopic observation on voice cultivation, and have been content to advise singers to accept the teachings of science in this direction, taking laryngoscopic evidence as that of an eminently credible witness; but it is submitted that the same rule here holds good as with any physical study, say, anatomy or botany, which, being rendered easier by plates than by un-illustrated text, is made still more intelligible by demonstrations *vivâ voce* than by reading, but is only learned in perfection for practical use by viewing and handling the objects themselves.

It is clearly only by such intimate acquaintance and comparison that a useful knowledge of a subject can be gained, and it is inconceivable to me how a singer of the least intelligence is to be more frightened, or made nervous by looking at plates of the larynx or by seeing in a mirror the working of his vocal ligaments, than, by the same process, witnessing movements of lips, tongue, and soft palate.

I don't ask that a singer shall study more anatomy for the purpose of a solid foundation of his art than would a painter. For the latter purpose it is necessary that the student know the proportions of the bony skeleton; whence arise and where are inserted the various muscles of the human frame which account for the several movements of the body; but he need have no knowledge of arteries or nerves. An architect, again, need not know the exact mode of making each variety of brick and other articles of building material—he

will be none the worse if he does—but at least he must know how many bricks will be wanted for certain work, what depths of foundation are required, what support is necessary for a given amount of weight, and many other details as to the structure of his building before he give his mind to decorations. Ornament, however elaborate, will prove little compensation for insecure foundations of an over-weighted building. Nor would I advocate that a singer should sing habitually, or even practise exercises with the laryngeal mirror in position, but I urge most strongly that, in his endeavour to perform some vocal act accomplished in the larynx, his efforts will be much more rapidly and completely successful if he learn to look into the voice-box of others, and into his own. It may be, as is asserted by some opponents, that the resultant tones will not be so fine as if no mirror were there. It is unnecessary to discuss this, since the method is not advocated for artistic exhibition or even for ordinary vocal practice; but, as there is no reason why the laryngeal mechanism should be practically changed thereby, nor any evidence to such effect, the argument is valueless against the truth of the lesson such investigation may teach. So far from proving a hindrance, the student will find that the process will give increased powers in laryngeal agility to a marvellous degree, and he will be able to turn the laugh against those who, through ignorant obstructiveness, may attempt to ridicule my contention.

I have been led to form the more advanced views here indicated on the importance of laryngoscopic self-observation of the mechanical act of singing, as a groundwork of its development as a fine art, by consideration of certain facts which have recently come under my notice. I have learned that Pauline Lucca can trill with the laryngeal mirror in position: since then, I have seen with what ease my friend Mr. Behnke and his young daughter, the latter after very little practice, can perform similar acts of vocal gymnastics in the same circumstances. Finally, I have read, in an able and interesting paper,* that Dr. Wesley Mills, of Montreal, has tested every laryngoscopic observation which he made on singers, to the number of fifty, by mirror-observation on his own larynx. The author gives evidence of such exceptional musical gifts as to

* "An Examination of some Controverted Points of the Physiology of Voice, especially the Registers of the Singing Voice and the Falsetto." By T. Wesley Mills, M.A., M.D., Assistant of the Professor of the Institute of Medicine, McGill University, Montreal. *The Journal of Physiology*, vol. iv., No. 2.

assure us of his thorough competence to perform this task with judgment.

And here let me make a confession of error and a recantation. The same writer very justly takes me to task for having stated in my "Medical Hints on the Singing Voice," published eight years ago, that I had failed to discover appreciable differences in the larynx sufficient to account for the whole cause of differences of voice in different registers. He kindly finds for me a way out of my difficulty, by himself suggesting that "the ordinary practice of the laryngologist does not furnish of itself observations of the extensive and accurate kind necessary to the examination of questions of so difficult and unsettled a character." This was my case. My time had been so fully occupied looking for disease that I had had neither leisure, nor opportunity, for studying the healthy larynx in the act of song; and it was not till five years ago, when I saw Mr. Behnke demonstrate his own larynx in the very rooms of the Musical Association in which my words had first been uttered, that I was convinced of my mistake. What I then learned was nothing less than a revelation—the result, a delightful surprise. Both the pleasure and the astonishment have since been continually reinforced by constantly renewed study and observation. This acknowledgment is due to science and other science workers: it may also serve as encouragement or as warning to those not yet fully aware of the lessons to be learned by exploring this equally profitable and entrancing realm of scientific observation.

Your chairman, in introducing me, has truly said that this subject of "Science and Singing" is a very wide one. I do not intend to go over the whole field, and to inflict on you a didactic exposition of the whole science of singing. I refrain for two reasons:—First, because I should want twelve hours, or twelve lectures of an hour, and should require from you far closer attention than I can expect on such an occasion, and secondly, because I have recently collaborated in an attempt to treat in writing this subject from a scientific standpoint. Not that I think we have done all that can be done in that respect. On the contrary, we are conscious that there is much more to be said which we hope to say at a future time; but in any case it is needless to travel over all that ground again.

I therefore purpose in this essay to take into consideration some points of scientific interest connected with only two of the factors necessary for the complex act known as singing. I hope to give

you such illustrations of the value of science in these connexions that your appetite will be whetted to give further attention to the study, not only from its very great intrinsic interest, but because you will see the importance of the bearings of science on the act.

Those who were present at the lecture given to this Society by Mr. Behnke last year, will remember that he very thoroughly explained the whole mechanism of the human voice. He said that it might be divided into four parts. 1. The method of breathing or filling the lungs, this act controlling the air or motor power of voice. 2. The production of tone in the voice-box by certain vibrations and changes in the vocal ligaments. 3. The re-inforcement of that tone in the resonator; and 4. The utterance of the same in the form of words by means of changes in the organs of articulation.

There is no necessity to weary you with a long recapitulation of what has been said by him and others as to the various methods of taking breath. We may note, however, that this question of respiration may be subdivided into two parts, the mechanical aspect of breathing and the chemical aspect of breathing.

The mechanical view of breathing need not now be considered in much detail because, always acknowledged of first importance, it has, in these later years, received even increased attention. I will simply ask you to agree with me that for the purposes of vocalisation, as for any other muscular act, it is necessary that we should be in a position to attain the largest amount of force in the easiest way, and that we should expend that force with the greatest economy. There are many books that will tell you what is the right way of breathing for the purposes of singing, and what is the wrong, and most teachers will tell you how to economise breath in singing. All will enforce the importance of taking breath at such points as not to interfere with the sense of the words or with the rhythm of the music, but this is an æsthetic not a scientific aspect of the breathing question.

Nor do I intend here to enter largely into the injurious influence of stays. There is a great deal yet to be said about it before women will admit the justice of our strictures in the only practical way—namely, by reform in this direction; there is possibly even a little to be said in favour of reasonable, rational stays, but very little indeed. I do hope, I have a gleam of hope, that some success is at last resulting from all that has been written, and that those at least who value their voices and their health more than what they are pleased

to call their figures, are awakening to the fact that a beautiful woman need not necessarily be a deformed one. At least, if they will deform themselves, there is less danger to their health in giving themselves, as is the latest modern craze, the shape of a camel than that of a wasp. But this impediment to full and free breathing is not confined to the ladies. Men are, to a great extent, sinners also. I recently saw a patient, splendidly proportioned, standing over six feet, who, by his height, should have been able to breathe 300 cubic inches, but who only breathed 260. On loosening a tight belt which he wore instead of the ordinary braces for suspension of his trousers, he breathed at once his full mean of 300 cubic inches. Clothing may impede respiration without constricting the chest, as may be tested by comparing the diminished breathing capacity of women wearing heavy cloaks or of men with weighty overcoats, with the increased result on removal of such encumbrances.

It is important to note, for the sake of those who are not singers, that this deep breathing, so necessary for the production of a full, pure voice, is also of considerable importance in relation to digestion, and, consequently, to the general health. Every one when exercising or performing muscular acts takes breath somewhat quicker and deeper than when in repose. The consequently fuller expansion of the lungs causes the muscle known as the diaphragm or midriff, and which separates the organs of respiration and digestion, to descend lower, and to squeeze more firmly over the liver and over the stomach. As a result, these organs are greatly aided in performance of their functions of digestion and assimilation.

But this free exercise of the diaphragm, so beneficial when the chest-walls are free, is painful when they are constricted, as may often be witnessed in a ball-room, in which a lady tightly laced may be seen, after dancing, to literally pant for breath, with considerable deterioration to comfort, complexion, and grace, and more or less serious injury to her circulation and health. To avoid misconception, let me also say that deep breathing, as now advocated for voice use, does not by any means imply forcible expansion of the lungs or undue blast in delivery, the word *power* signifying quite as much ability to control as force to execute.

Having said these few words on the mechanical act of breathing, let us consider it in its chemical aspect. From this point of view, we take air into our lungs for the process of the combustion

of our body. We take it into our lungs to oxygenate the blood, to get rid of the carbon in our system, and to obtain fresh fuel to go on with the burning of the candle of life, a comparison most apt, as I shall presently show you; for what happens in our lungs in breathing, happens also to a candle in its combustion on illumination.

Air consists of oxygen and nitrogen,—roughly, in the proportion of one of oxygen to four of nitrogen. Nitrogen only bears the relation to oxygen that water bears to brandy or to wine when the two are mixed for drinking. It has no action beyond that of a diluent. When we take this air into our lungs it is expelled as a different product. It is not oxygen taken in and oxygen sent out again. The oxygen when inspired combines with the composition in our blood formed in the process of combustion, so that it is expelled as carbonic acid gas, a mixture of carbon and oxygen. A portion of the oxygen also combines with the hydrogen in our system, and is expelled as watery vapour. Air also leaves our lungs warmer than it entered in consequence of contact with the increased temperature of our bodies over that of the inspired air, the temperature of our bodies being from 95° to 98° , and the external air being at what is known as temperate heat, of a temperature of from 55° to 60° .

I have said that the first thing with which expired air is charged is carbonic acid. This I will presently prove by experiment. But first, what is carbonic acid? In this glass bottle is carbonic acid gas. It is a very heavy gas. I might leave out the stopper of the vessel for some time and it would make no change in the gas. Being heavy, it would not rise quickly to diffuse with the external air. I could pour it from one bottle to the other. If it is united with lime-water, it will produce a mixture of carbonate of lime—that is, chalk—and by the amount of chalk that is deposited from the carbonic acid we can, by drying and weighing, estimate the amount of carbonic acid gas that had been in that bottle. My assistant now pours some lime-water into the bottle containing the carbonic acid gas. You see that the lime-water is perfectly transparent. On shaking the bottle, you see that it has become quite milky. That white mixture will presently settle down, and the result will be water with a deposit of chalk. Now, I will show you that when I breathe out into clear lime-water I bring about the same result. Here again is the same milky fluid, the same diluted chalk mixture. Let us go further: in this room there is a certain amount of carbonic acid gas. There is not as much as there would be if the door were not open, and if you had been here an hour

instead of a few minutes. We have here an india-rubber bag filled with air from the room, and as we allow this air to pass into lime-water we again see the same result. The fluid is gradually becoming milky. The air was collected in the room before it was so full of people. If it had been collected later the result would be still more striking. The carbonic acid gas in the atmosphere is usually about 3 to 4 in bulk in 10,000 parts of air, and this can be inhaled without injury to health. In fairly ventilated rooms there may be as much as six parts. Certain experiments that have been made by Pettenkoffer and Dr. Angus Smith show that in some circumstances it is much worse. For instance, three feet from the floor in the old Court of Chancery with closed doors there were found to be 20 parts of carbonic acid gas in 10,000 parts of air. In the same court with the doors open there were only 5 parts in 10,000, a fact showing the advantage of ventilation.

I told you it was a very heavy gas. Certain experiments in theatres show that the gallery of a theatre contains less than the pit. That is an important thing for our less affluent friends in the gallery; although they endure more heat, they do not inhale as much carbonic acid gas. This gas induces sleepiness, and causes death by gradual suffocation. Possibly in the greater scarcity of carbonic acid gas in the air of the gallery, as compared with that of the stalls, may be found a reason why our friends in the gallery are more lively—not to say, sometimes more noisy—than those in the lower regions of the house. The facts that the products of combustion are not only carbonic acid gas, but also moisture, that is, watery vapour, can be proved in a very simple way. If you breathe on a glass, it becomes dim, and you know that your expelled breath is warmer than when it was inhaled, because it seems literally to steam in cold weather; and on the veils of ladies, or the moustaches of men, the moistened breath will be seen to be more or less condensed or frozen, according to the temperature of the external air. Here is a little experiment in further illustration of the same fact. I have a candle lighted, and floated on coloured water, and then covered by a bell-glass. The first thing that happens is that the glass becomes dimmer. Gradually, as the oxygen is exhausted in the vessel, the candle goes out. The air contained was, as I told you, four parts of nitrogen and one of oxygen. Suppose we could burn the oxygen without at the same time any other product, one fifth of the space contained within the bell would be occupied by the coloured water, which, as you have seen, rises in the glass to supply the

vacuum formed by the loss of oxygen. But a portion of the oxygen has been occupied in combining with another gas, the product of combustion, namely, the hydrogen, with the result of forming the watery vapour which has dimmed the bell-glass. Therefore, the coloured water does not rise to quite the full extent of one fifth. If, now that the candle is gone out, we carefully introduce another one lighted under the bell-glass, the flame is immediately extinguished, because the air has lost all its oxygen and the gas now there is carbonic acid gas—a gas poisonous to life and destructive to illumination. Beside this question of the gases, of course there are a great many actual particles of an injurious nature constantly floating in the atmosphere—a great deal of dust more or less poisonous. Such dust is probably to be found in its worst form in a ball-room on account of the agitation of particles of a chemical character falling from the dresses and artificial flowers of ladies.

It is important to consider the effect of poisonous air on the singer or actor. We sometimes, for the reason I have explained, feel very sleepy and very oppressed in a hot room, in the opera, theatre, or church. I fear that we do not always consider that those who are endeavouring to entertain us or instruct us may also be suffering, because they are actually using muscular force under the unfavourable circumstances of a poisonous atmosphere. Mr. Behnke tells me that one evening sometime ago he was giving a laryngoscopic demonstration of his voice in a room oppressively hot, in consequence of gas-light, and he entirely lost his voice; he went into a back room, where there was no light, and where, consequently, the air was purer and cooler, and in a very few minutes he recovered his voice entirely.

Some months since, I met a very distinguished actress coming out of a theatre, after an afternoon performance of a Shakesperian play; she was an instance of what members of her profession invariably do whenever they are not playing themselves—they take the opportunity of going to see their neighbours, it may be to gain a lesson how to do better, or for other reasons more gratifying to their self-love. At any rate, this lady, who is more than any one I know always willing to learn, was there, I doubt not, for purposes both of enjoyment and instruction. Her daily habit is to dine about three o'clock, to rest from about five o'clock to six or half-past six, and she is engaged to play nightly a very arduous part from eight to eleven. I asked, "Are you going home to rest?" She replied, "No; I am going out to dine with friends, and thence to the

theatre." About half-past eleven that night, I was sitting at home, when my bell was rung, and, the door being opened, there entered to consult me this very lady, who had entirely lost her voice during the course of her performance that evening. She was perfectly well in the afternoon. What had happened? On leaving the not too well ventilated theatre, she had gone to a restaurant; she had sat talking with friends. I said, "Did you take any rest as usual this afternoon?" "No," she replied. "Were you quiet during dinner?" "Not a bit of it; I chattered like a magpie, I talked the whole time." Here is the explanation. She had never given either her body or her voice rest. She had taken her dinner nearly three hours later than usual, going from dinner to the theatre with the meal half digested, and, moreover, she had sat in a hot theatre or restaurant the whole afternoon, going from one to the other in a brougham kept closed to prevent her "catching cold"—of that she assured me she had been most careful; but by this means she had lost a chance of inhaling any supply of fresh air to rid her lungs of the poisonous atmospheres in which she had passed her time. She had given rest to neither body nor voice that evening: the consequence was that both bodily and vocal strength had given way when called upon by the exigencies of her performance. My advice was simply to go home to bed, to take no medicine whatever, to walk out for an hour the next day, and to rest well in the afternoon; and my prophecy that the voice would be all right the next evening was most satisfactorily fulfilled. This anecdote enforces a great lesson, which all who hear, singers and non-singers, should take home to themselves. It proves how important it is that those people who have to use their voices or their bodily strength should take very great care to obey nature's laws, and how certain disobedience is to be punished by loss of ability for tasks undertaken. I say "certain," for I could quote hundreds of examples not less striking, of similar import, both as to cause and result.

This question of injurious atmosphere leads me to say something concerning a very fashionable entertainment, against indulgence in which I beg to caution particularly all my singing hearers; that is a "smoking-concert." I do not know anything more cruel or more likely to upset a singer than a smoking-concert. It is very much encouraged by our brethren in the art of the brush and pencil; but what would a painter say if asked to go and take a picture from nature with a sunny effect, the scene being enveloped in a thick fog? If there must be smoking-concerts, they should, as far as performers are concerned, be instrumental

and not vocal. Unfortunately, it is not only the gas and smoke, but there is generally whisky-and-water going round, and not only is some consumed, but the air is charged with alcoholic fumes. I have attended smoking-concerts. I do not indulge in spirits and never drink anything stronger than soda-water on these occasions, but I have never been to a smoking-concert without having a headache on the following morning, and I well know that my experience in this respect is by no means unique. Independently of this question of atmosphere, smoking-concerts are not always the most quiet parties, and the singer or reciter has often to force his voice unduly so as to be heard above the din of glasses and chatter, not perhaps in his immediate neighbourhood, but in adjoining rooms or at the "buffet" end of the apartment in which he is singing or reciting. For all these reasons, I venture to urge that smoking-concerts should not be multiplied, though I fear the contrary, by reason of the high patronage extended to them, and from other indications not necessary to detail.*

It is not to be wondered at, when we consider how much the condition of the air and climate may influence the voice, that there should recently have arisen a desire to give us something better. We doctors are in the habit of saying, "Get as much fresh air as you can, go to the sea-side, get a walk out in the park, or something of that sort": and in the case of a singer, "Well, though it might be unwise to walk home at night from a hot building through the cold air, and with your throat necessarily somewhat congested after functional use, you can, at any rate, take outdoor exercise during the day." There has, I said, arisen a desire to substitute something better, and there has been recently introduced to our notice something of which you have probably all read in the public press, namely, "Artificial Italian air," guaranteed to give people the

* If justification were wanted for authoritative direction regarding the hygienic conditions of atmosphere and diet to be observed by singers, it would be amply illustrated by the remarks of the gentleman who first spoke at the end of my lecture. He stated that he was "in the habit of dining frequently with professional singers, and had noticed that at the end of a very heavy dinner—consisting of a dozen or fifteen courses—those singers would get up and be enabled to sing most beautifully, not only solos, but to join in part-songs. He had also attended smoking-concerts, and during the whole evening singers who were there, even after a very heavy dinner, would come forward and sing most beautifully." Several other speakers so effectually answered him that there was no necessity for me to say anything; but my friend and colleague, Dr. Dundas Grant, especially hit the mark when he observed that, to be in a condition to appreciate singing in such circumstances, the audience should have undergone the same preparation as the singers.

voice which is believed to be the peculiar property of the Italians. Seeing that this scheme has been advocated as if from a scientific standpoint, and by some who at first sight appear to have scientific pretensions, and that it has been paragraphed in almost every paper, even in organs of my own profession, it is my duty, as claiming by my calling to be scientific, to argue this matter, not to dismiss it contemptuously in a few words, but to examine it carefully, so that I may be able to speak with knowledge as to its value; and I think it is my duty, as a member of this society chosen to lecture to you, to give warning as well as encouragement to those who desire to perfect themselves in the fine art under consideration. I had the advantage of an interview with the gentleman credited with the introduction of this Italian air, and I learn that an application for a patent has been made by him, "Robert Carter Moffat, chemist, and Thomas Gilbert Bowick, manufacturer, for an invention for an improved composition and apparatus for strengthening and extending the range of the human voice, and for the treatment of pulmonary and other affections." Now, if this invention could achieve such an end, it would be very valuable, and would go far to abolish doctors, at least those who practise in the same special branch of medicine as myself. That, after all, is a small matter; the minority must suffer in the interests of the majority.

We have to ask the question, in the first place, is the contention true that the Italian voices are finer voices than any other? I deny it. Some years ago I had occasion to write upon this matter to the *Times*, in opposition to a like contention on the part of the late Sir George Bowyer, and I then mentioned that at a recent performance at the Italian Opera, so-called, of "Fidelio"—written by-the-bye by a German—almost every character had been taken by members of other nationalities than the Italian; the soprano, the late lamented Mdme. Titiens, was a native of Hamburg; the contralto, Mdlle. Bauermeister, was also of the same nationality if not born in the same city; the tenor, Urio, was a Roumanian; the baritone, Signor Campobello, was an Italianised Scotchman or Englishman; and only the second tenor was an Italian. Anybody who knows anything of the chorus of the Italian operas is aware that in its body are comprised as many English and French as there are Italians. Here is a paragraph taken from the *Pall Mall Gazette* of December 3rd, 1883, in further illustration of this first consideration of our question:—
 "Among the great artists now in America, it is stated that Mdme. Patti was born in Spain; Mdme. Nilsson is Swedish; Mdme. Gerster,

Hungarian; Mdme. Alwina Valleria and Mdme. Minnie Hauck, American; Mdme. Trebelli, French; Mdme. Sembrich and Mdme. Pappenheim, German; while the leaders of the Italian party are Mdme. Scalchi, Signor Campanini, and Signor Galassi. Mdme. Albani is a French Canadian; Mdme. Marie Roze is a French lady, but was partly educated in an English boarding-school; Mdme. Pauline Lucca, Mdlle. Tremelli, and Mdlle. Stahl are Austrians; M.M. Gaillard and Nicolini, French.* So you see that voice as a gift is cosmopolitan. I contend that in England—especially in Lancashire and Yorkshire, and also in Wales—there are, in proportion, as many fine voices to be found as in any region in Italy, ay, and as much love for music. What is it, then, that has given the Italian vocal school its admitted superiority? First, and to a great degree, what is known as the old Italian method of teaching. There is no doubt that the old Italian method is the method that science has proved to be the true one, just as in the arts of painting and sculpture, and other things, the old Italians, before science could explain principles and give reasons, knew and taught what was right. This method has been conveyed by tradition from master to master, but, like many other of the Italian art traditions, it was lost; other kindred arts have been lost in modern times, and their renaissance is being brought about by the influence of the teachings of science. With the loss of the traditions the Italian school sadly deteriorated.

Another admitted reason for Italian superiority in song is the language; let us see in what particular it is that the Italian language excels for purposes of singing? The characteristic of the English language for singing is that the sibilants are very harsh; in Italian they are very soft. The German language is very guttural, as is the English, though in less degree; of that characteristic the Italian is entirely free. The Spanish, which has been likened to Italian, is also guttural, and in this respect the Spanish, although often compared to the Italian, is very far in the background as a singing language. The French

* Those unacquainted with the history of music appear to quite overlook the fact that only in the sixteenth century did Italy attain the high position she held till recently as the Land of Song. For two centuries previously the Netherlands had reigned supreme, and artists from that region were invited upon the most favourable terms to Italy, France, Spain, and Germany. The last-named country has succeeded to the position of Italy, and if no longer in the ascendant, probably still takes the lead, the music of its school exerting an influence over that of all other nations. Who shall say whether England, so long contemned as a musical country, even by her own sons, may not some day succeed in turn to the first rank?

language is considered a fine language for song, but it has the defect that many of the vowels are close, whereas the Italian are open. It is in the absence of the guttural quality, in the softness of the sibilants, and, above all, in the openness of vowels, that the Italian language excels as a language for developing the voice. It is its beauty in "vowelisation," to coin a word, that causes it to surpass all others for teaching vocalisation. Doubtless, pronunciation of consonants is improved by study of the German language, while the æsthetic element of song, the power to move the heart of an audience, is best conveyed by the artist singing in his own native language. If we would know how ridiculous our own attempts at Italian singing must often be, let us consider how frequently the effect of English and Scotch ballads is exactly opposite to that intended when sung by even the most gifted of foreign singers with imperfect pronunciation of the language; but all this has nothing to do with Italian nationality.

It is not true that Italy has exceptionally the gift of song, or the gift of composition. In times gone by Italy has produced magnificent composers, and even now possesses the great Verdi; but, at the same time, Verdi's later music is, by competent judges, believed to be better than his earlier compositions. Why? Because he has supplemented his great gift of melody, the national characteristic of Italian music, by the greater and more powerful influences of the German school. The Italians are possessed also of warm artistic temperament and sympathies. Nevertheless, it can hardly be gainsaid that Italian art, from the highest point of view, is in its decadence. Take, for instance, Italian painting, and especially Italian sculpture, which last is often unworthy of the marble that is employed; the subjects are no longer classical and grand, they are meretricious and poor, and Italian art generally, whether painting or sculpture, is bad French. I fear the same applies largely to music. Italian opera is still carried on by certain public-spirited and persistent gentlemen, if not at a loss, at certainly but moderate gain. The opera, not of the future, but of to-day, is German opera, and English opera founded on German education and German tradition. Those who have watched the career of such of our young English composers as have, in recent times, made a success in opera—and we have heard many fine compositions lately—are aware that the success, especially of one which has been received in a very generous manner on the Continent, is mainly

due to German education. Therefore, when we hear Italy talked about as being the exclusive or chief land of song, we must treat the assertion as one of those postulates which, when examined critically, is found to be, not a matter of fact, but of romance.

Having so far cleared the ground, we now come to the question of Mr. Moffat's invention. He told me, in the presence of some friends, that he was led to seek for artificial Italian air, because he found in the dews of Italian plains peroxide of hydrogen. He said he also found more free ammonia—I quite believe him, and I will presently tell you why—in Italy than can be found elsewhere. Now, we will first take the peroxide of hydrogen. What is it in peroxide of hydrogen that is going to give us a voice? Oxide of hydrogen is water, and composed of two parts of hydrogen with one of oxygen. Peroxide of hydrogen contains two parts of hydrogen and two of oxygen, the second atom of oxygen being very easily given off and existing in a *negative* polar condition. Its other name is that of Antozone, to distinguish it from Ozone, which is considered to be the *positive* polar form of oxygen.

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Having explained to you something of the nature of the two gases constituting peroxide of hydrogen, let us see what the compound itself is, for, of course, the combination may have a quite different effect from that of its constituent elements. This that I hold here is perfectly pure, and, as you see, resembles clear water in appearance; it is in point of fact a solution of peroxide of hydrogen in water of a strength known as ten volumes. There is but very slight evaporation, it is without smell in solution, though the gas itself has a very distinct chlorine-like odour similar to that of ozone; it has but a very slight taste. It is said, in chemistry books that I have consulted, to injure the epithelium of the skin and to produce itching; on this account those employed in the manufacture of it are obliged to wear india-rubber gloves; it is said also to produce great discomfort in the mouth, roughening of the tongue and lining membrane and thickening of the saliva. This would be the case in stronger solutions or in preparations less chemically pure than the one before you. There are very beautiful tests for peroxide of hydrogen, one of which, the chromic acid test, I now illustrate. The presence of only one drop of a ten-volume solution of peroxide of hydrogen gives a prompt reaction of the characteristic sapphire colour. If I add ammonia to that, this colour will disappear, the fact being that peroxide of

hydrogen is a very unstable gas, especially so in presence of such an alkali as ammonia; to enable it to be kept for use it is necessary that it should be acidulated, and so for commercial purposes the solution generally contains hydrochloric or some other acid.

Now, I have here some of Mr. Moffat's mixture supplied by Mr. Moffat himself. He told us, and he has published, that his mixture contained, for one thing, peroxide of hydrogen to saturation. I take some of this mixture and repeat the experiment made just now with pure peroxide: I pour in, not a drop, but any quantity of it, into the same test solution employed just now for detection of peroxide of hydrogen, and you see that we obtain no sapphire colour, there is no reaction whatever of peroxide of hydrogen. Now it might be remarked that this mixture contains ammonia, and that, therefore, the ammonia prevents this reaction from being manifest. As a matter of fact it would not do so, but I add some hydrochloric acid. You see a large volume of vapour, which is that of chloride of ammonium, given off. We put in sufficient acid to neutralise the ammonia, but in spite of that there is no reaction of peroxide of hydrogen.

Another very beautiful test for the presence of peroxide of hydrogen is that with permanganate of potash; a solution of this salt of the well-known magenta colour, when dropped into a solution containing peroxide of hydrogen, is immediately bleached, and if a definite strength be employed a calculation may easily be made of the exact amount of peroxide contained in any given solution. This test cannot be employed satisfactorily with Moffat's mixture, because the fluid is already of a dark colour. The one I have shown is, however, conclusive, and, having had it confirmed by two eminent chemists, I venture to say, with all deference to the inventor, that, however much peroxide of hydrogen he may originally have put into his preparation, it has all disappeared. Whether this disintegration or disappearance is in consequence of its combination with the ammonia or with the organic saccharine medium in which it is suspended need not concern us. Either or both are sufficient to quickly destroy its existence.

We must now consider the value of the other element, namely, the ammonia; and, from the fact that the instrument is called the *Ammoniaphone*, I judge that ingredient to be considered of at least equal importance in the eyes of those who recommend it. It is sufficient for you to know that ammonia is a highly irritant and poisonous gas, extinguishing flame, and therefore analogously destructive to

life. Ammonia is essentially the product of putrefaction and decay. This is why I expressed a belief that there was plenty of free ammonia to be obtained in Italy, because a more vile and unsanitary state of things than exists in Italian towns, and villages, and hamlets is not to be found anywhere. Thanks to science and more general observance of the laws of health, sanitation is in a better state in England, and therefore we do not get as much ammonia in England as we do in Italy. Let us take Naples as an example. All will agree that Naples is not sanitary; added to that, its natural climate is trying and fickle. Ammonia has the property of being taken up by moisture to such an extent, that one part in bulk of water will take 670 times its bulk of ammonia. This is a provision of nature for minimising its ill effects, for otherwise these horrible gases of putrefaction would be much more poisonous if the ammonia with which they are charged were not, to a great extent, absorbed by moisture. When ammonia is present in drinking water it is an undoubted evidence of organic impurity of the most noxious character. As the Italian air is dryer than English air, it is possible to believe that there would be more floating ammonia in that country; but I cannot admit that it is on such account any more desirable. Let me also remark, *en passant*, that it matters not regarding the poisonous effect of caustic ammonia, such as is found in this mixture, whether it be a product of putrefaction in towns or an exhalation in valley and sea-shore; not that I admit that free volatile ammonia is ever found on sea-shores or in volcanic regions, or anywhere else, except as a product of putrefaction. It is a very different matter when found in a neutral state as chloride of ammonium (sal ammoniac) or as sulphate of ammonia, and I repeat that it is not found in either of these neutral forms in Moffat's mixture. Caustic ammonia is never employed as an internal remedy in medicine, and in its volatile state it can have no good effect when existing permanently to any appreciable extent in the air. I previously said that ammonia is exceedingly irritating; this you may all have experienced when breathing the vapour of smelling salts, the beneficial effect of which is not so much in the ammonia as in the stimulus to reaction by the spasm its irritant vapour engenders.

You have seen by a recent experiment that there is a large amount of ammonia contained in the mixture under examination. You have seen the fumes of chloride of ammonium on the addition of the acid. I take now a little hydrochloric acid and put it into a bottle, and then add a little ammonia; you at once get these fumes exactly the same as

you saw them on addition of the acid to Moffat's mixture. That shows that there is a large amount of free caustic ammonia in this mixture. There is also some proportion of peppermint, and there is some proportion of treacle, or of some other inert saccharine medium, which, so far from holding the peroxide in stability, is quite sufficient cause for our being unable to find any, since its presence leads to quicker de-oxidation.

It has been said that, because peroxide of hydrogen has been prescribed for whooping-cough and other diseases, therefore, it is *a priori* likely to be of service to the voice; however that may be, the mixture contains none of this compound. I learn from printed circulars regarding this mixture that the voice of its inventor "was originally very weak, harsh, and destitute of intonation. By the use of the ammoniaphone it has now become a pure tenor of extraordinary range, capable of responding in a charming manner to the feelings acting on the vocal chords." However that may be also, the change was not due to peroxide of hydrogen.

I have further been challenged to deny that peroxide of hydrogen exists in the dews of Italy. I am not in a position to do so, but that point is also entirely beside the question. Nevertheless, I have no hesitation in expressing a doubt as to its existence in the dew and air of the South in excess of what can be found in the pine-forests of the North or the Eucalyptus groves of the antipodes, these being admittedly the most abundant natural sources of the gas. I should not, however, venture to affirm that the presence of peroxide of hydrogen in Sweden was the first cause of a Jenny Lind or of a Nilsson any more than I would admit it to be a likely factor for converting a Carter Moffat into a Mario. Looking to the well-known use of peroxide of hydrogen as a golden hair-wash, I might as well expect to see Italian brunettes converted in appearance into Saxon blondes.*

* Regarding the question of climate, I expressed the opinion, in my "Medical Hints" (page 38), that the injurious effect of various climates on the voice is generally much exaggerated, giving instances of the immunity from catarrhal loss of voice which the best singers,—such as Patti, Albani, and Santley,—enjoy quite irrespective of the countries in which they may be professionally engaged. Regarding the Italians, I have been informed, on credible authority, that Mario, in common with many others of his co-patriots, found his voice in better condition in England than in any country he visited. A writer in the *Lancet* has also remarked that, "while English pupils studying in Italy do not experience the remarkable effects claimed for Italian air, Italian vocalists in England, contrarywise, do not lose their own special brilliance of tone." The Editor of *Health* (Feb. 22, 1884), commenting on this statement says, "This looks like a sensible criticism, and suggests that, after all, race-peculiarity and not peroxide of hydrogen, lies at the root of the Italian purity of song."

So you see that, with reference to this question, neither on grounds of what we know of the Italian voice and the nationality of great singers, on grounds of chemistry, of physiology, nor any other ground, is there any reason to suppose that a mixture containing pure ammonia, or impure ammonia with a mixture of sugar and peppermint, is likely to be of service to the singer; I go further, and I say, it is likely to be of great injury. I have been told that I was prejudiced, before my friend, Mr. Behnke, tried it. I confess it. I was prejudiced by my medical education, knowing very well that ammonia was an injurious thing, that peroxide of hydrogen could not be given off very easily in the way of inhaling from any watery solution, and that such a mixture as I have described, when poured into a tube stuffed with tow, which was advertised as sufficient without renewal for a year's use, could not give off any appreciable amount of beneficial vapour at the end even of a day. It has been asserted,—not very ingenuously, I must say,—that this is simply a method of inhaling; and we are told that in the process is achieved the late Professor Simpson's prophetic Millennium of drug administration by inhalation alone. But part of the directions are that the singer is to take the fluid itself internally and then to inhale.

By agreement, the composition was to be given a fair trial, according to Mr. Moffat's personal directions; but in a few days Mr. Behnke reported that he had been obliged to discontinue the experiment, because the process produced such an amount of relaxation of his throat, and that of the pupils on whom he had tried it, that several days elapsed before recovery from the ill effects. That was just what I expected; for it is exactly what happens with all kinds of Cayenne pepper lozenges, and with all irritants acting as temporary stimulants to the resonator of the voice. Since all stimulation implies reaction, artificial bracing such as I have indicated must carry its punishment of reactionary relaxation. It is an inevitable law, and is evidenced in this instance by the effects of the ammonia and peppermint. I eliminate from all consideration the peroxide of hydrogen; whatever its value, it need not further be argued, we having found none. If, as is possible, it is capable of being of more extended service in disease, it must be administered in a more rational and scientific manner; and then, not as a royal and general road to voice-manufacture, but under medical direction in suitable cases.

It is doubtless desirable that singers should have more oxygen in

public buildings in which they are performing ; but the best method of increasing the purity of the air, with the least possible injurious stimulation, is to obtain the oxygen as ozone, which, as I told you just now, exists as an opposite polar state of oxygen to that of peroxide of hydrogen. It is to be found at the seaside, on mountains and in the country : you will find none in towns. You certainly would not expect to discover it in Italian towns or dwelling-places.

Ozone can be made by the action of any electrical battery, such as you see here. As the electricity is generated ozone is given off. If I put a piece of iodised starch-paper in the jar, you see it is coloured violet ; this is the commonest test for ozone. Another method by which its presence is proved is to add to the jar containing the ozone a weak solution of permanganate of potash ; in shaking it up, the colour is entirely bleached by the ozone. This is altogether a much stronger form of free oxygen, and much more effective than is the oxygen got from peroxide of hydrogen ; but it exists in the atmosphere without irritation only in the proportion of one in ten thousand parts.

The late Sir William Siemens devised a method of generating ozone by driving air through an electric coil, and in this way proposed purifying the atmosphere of buildings. So there is nothing new in this proposition. But another way in which ozone may be generated is by the open or arc electric light. This form of illumination exhausts but little oxygen from the air, and more than compensates for such loss by its production of ozone. The incandescent electric lights, such as one sees at the Savoy Theatre, abstract no oxygen from the air. On the other hand, they give off no ozone, the light being confined in an hermetically-sealed glass globe. The offices and composing-rooms of both *The Times* and *Daily Telegraph*—possibly also other newspaper buildings—are lighted by open electric lights, and the health of the staff must necessarily be much improved thereby. If there be one calling above others in which a pure atmosphere be a necessity, it must be such a one as that of officials, and especially of type-composers, employed on the staff of a daily newspaper, in producing which night is almost literally turned into day. It is to be hoped that all such buildings, all opera-houses, theatres, and concert-rooms will ere long be so lighted. The perfection of such a light, so far as purity of air for audience and performers alike is concerned, will, I venture to think, be a combination of the open arc and of the closed incandescent systems. By this means a minimum of oxygen will be exhausted, and a certain amount of ozone will be set free to purify the

air, to the advantage of both performers and audience. For the central top light and for stage effects now rendered by lime-light the arc will best answer on account of its increased brilliancy and illuminating capabilities ; for foot-lights, wings, passages, and the body of the auditorium, the incandescent. The question of glare is a question only of shade, and this, as well as other difficulties, thought, in the early history of electric lighting, to be so great, are already more than half solved. Looking to the length of debate and other circumstances connected with recent sittings of the House of Commons, it is doubtful whether a method of illumination supplying a more invigorating atmosphere to those regions is either desirable or necessary.

I have dwelt some time on this question of breathing from the chemical view, because it is even more important that the air breathed into the lungs should be of good quality than it is that the lungs should be inflated in the right manner ; and, for the due appreciation of the efforts of the singer, it is quite necessary for the audience not to be poisoned. It is recognition of this great want of pure air that has created an increased interest in this scheme of artificial air, and it is for this reason that I have given it so much attention, more even than some may think it deserves. I was, moreover, anxious to illustrate in my remarks on the subject—taken simply as the particular one enforced on the attention of vocalists at the present time—that few of these royal roads to perfection will bear critical examination. Your time will not be wasted if I can bring home to you the wisdom of not accepting everything that is offered on the recommendation or testimony of unqualified, interested, or irresponsible individuals. I have, moreover, endeavoured not to be entirely iconoclastic, and, if I have demolished all hope of benefit from inhalation of artificial Italian air, I have indicated to you other means, easier and surer, of purifying the air of the buildings in which our singers most do congregate.

We will now turn to quite another portion of the large field of science in relation to singing. I mean some questions as to tone production itself in the larynx, or voice-box, as effected by the passage of air propelled from the chest against the vocal ligaments, and the varied modes in which different tones may be produced by varying action of the muscles regulating the vibration of these ligaments ; in other words, let us give brief but earnest consideration to varieties of voices, and to a few facts concerning the various “ registers ” of the voice.

It is necessary that we look at the voice in a broader view than that in which people generally regard it. The bass is only a part of the instrument, the soprano is only another part ; by going from one end of the scale to the other of the human voice you get an idea of what a grand and marvellous instrument it is. My friends who are here behind the screen, for a purpose that I will acquaint you with presently, will now sing from bass up to soprano, and you will hear at once what an extended compass the human voice has. It may, in the range from deep bass to high soprano, have a compass of five and a half octaves : each variety rarely exceeds two, and a compass of two and a half octaves implies possession of a very extended range.

The next illustration I desire to give you is in relation to the difference between the male and the female voices. It is often said that the female voice is *simply* a reproduction of the male voice an octave higher. This is an instance of one of those unscientific statements made by persons of educated or scientific pretensions which can be shown to be erroneous with hardly more than a moment's serious consideration. If the female voice were *simply* a reproduction of the male an octave higher, the soprano should produce the voice by exactly the same mechanism as the tenor, and the contralto by exactly the same mechanism as the bass ; but they do not, and we know that for similarity of voice between male and female we must look to the tenor and contralto. The tenor has a few notes lower than the contralto, who, on her part, possesses a few notes higher than the tenor ; but within certain limits the voices are produced by the same mechanism, and, provided a contralto and a tenor are chosen of similar timbre of voice, it is often difficult to distinguish (their figures being concealed) whether a produced tone be that of the male or the female. [This experiment was made on the occasion, and, until the audience was accustomed to the tones, there was considerable doubt in the direction indicated.]

One of the most interesting illustrations of the influence of science in deciding questions in relation to singing is that of the various registers of the voice. Accepting Mr. Behnke's simplification of Garcia's definition of a register, as "a series of tones produced by the same mechanism," we hold with Madame Seiler and all later scientific teachers that there are five different mechanisms or means in the larynx of producing all the various tones of which the human voice as a whole is capable. Neither a bass nor soprano possesses five mechanisms or registers ; on the other hand, the mechanism employed

by the bass to produce his low notes is quite different from that used by the soprano to produce her high tones. Of the existence of these various registers there is not the least doubt in the minds of those who are properly educated. Whatever doubt there was formerly, has, since the introduction of the laryngoscope, been absolutely dispelled by the observations of those practised in the use of this instrument. Dr. Wesley Mills, to whose valuable paper I have already made reference, particularly deprecates criticism from unqualified individuals. Speaking of opponents of Madame Seiler's teaching, he says:—"Her treatment of the registers, particularly their divisions, has been subjected to a good deal of criticism, and certain writers, not belonging to the ranks of science or to the medical profession, have imported not a little warmth, if not bitterness, into their discussions. Of this latter class of writers who seem to think such questions can be settled by a few bold dashes of the pen, no notice will be taken in this paper." Nor need the ravings of such persons concern us here; they are not even amusing, but simply lamentable from their ignorance and from the evil they may effect on such as may be influenced by them.

Garcia, as inventor of the laryngoscope and the first laryngoscopic observer of physiological truths with regard to laryngeal action in tone production, gave three registers. Madame Seiler adopted the same division, but in her treatment amplified to some extent the views of Garcia. In the main we agree with Madame Seiler.

Dr. Wesley Mills has in detail analysed Madame Seiler's views, and he has most carefully tabulated and summarised laryngoscopic observation of the mechanism employed for production of various tones in fifty separate individuals; each observation was made by himself, and, as previously stated, was afterwards confirmed by self-examination—that is, by auto-laryngoscopy. The following is the result in his own words:—

"Mad. Seiler may have drawn the lines on this matter of registers too sharply, but it seems to me that the above record of my observations confirms her views in many important particulars, and I consider the work which Garcia began, and which she has so extended, of very great value."

With such an almost unqualified agreement on the part of Dr. Wesley Mills, I must express my great astonishment that, at a recent lecture, I heard it stated in so many words that the conclusion of Dr. Wesley Mills, as the result of his careful and competent experiments, went definitively to settle the question of registers, by showing that there were but two registers in the human voice—the chest and the

falsetto. I boldly say that there is not a line in Dr. Wesley Mills's paper justifying such a deduction from his views, which are in accordance with those of the eminent authorities already mentioned, as well as with the valuable researches of Gruetzner and others quoted in our own work on "Voice, Song, and Speech."

Regarding two of the divisions of the registers to which I have alluded, and generally known as the chest and falsetto registers, but denominated by the late Mr. Curwen the "thick" and the "thin," we see, when we look down the throat with a laryngoscope, that in the "thick" register the whole body of the vocal ligaments, in length, and breadth, and substance, is thrown into violent vibrations. In the "thin" register, the vocal ligaments are almost passive. In the one case, there is much more of the intrinsic muscle of the vocal ligaments in motion than in the other. To further prove this contention, the experiment was made of passing an intense light through the neck, just below the situation of the vocal ligaments, so as to illuminate them from beneath. The result was, that there was seen a distinct difference of transparency of the ligaments in the two registers. In the "thick," the ligaments were opaque, and but little light was transmitted, while in the "thin" they were more transparent. The experiment, tried with varying success, was by no means decisive, and it has been only since the application of electric light that we have been able to confirm it. Only the day before yesterday (Feb. 12), after several failures, Mr. Behnke and I succeeded, in the presence of several scientific gentlemen, at the Society of Arts. An electric light of 10,000-candle power was placed at our disposal. The room was darkened, and every glint of external light was excluded, except where it was concentrated on to the throat of Mr. Behnke. I then introduced the laryngeal mirror, and I saw at once that, when he sang in his "thick" register, the vocal ligaments were opaque, to a very large extent; there was such an intense light, that I could distinctly see them, and they were of a deep red colour. In the "thin" register, there was almost absolute transparency of at least two-thirds of the breadth of each vocal ligament from the middle line, and along the entire length. We intend to repeat the experiment, and I have not the least doubt but that we shall find the same appearance in the larynx of others. This not only confirms the fact that there is a "thick" and a "thin" register, but the thorough propriety of the terms suggested by Mr. Curwen (to whom followers of the art of singing are in so many other ways indebted) is by this experiment com-

pletely justified, fulfilling as they do the ideal principle of all scientific nomenclature—an indication of an actual fact.

Intimately in connexion with this question of registers, a right knowledge of which has the most important bearing on voice cultivation, is that of early education of the voice. Eight years ago I urged, in my "Medical Hints," that children might be taught to sing at a very early age, indeed, so soon as they could read. I gave this advice, for one reason, because I thought singing lessons, as I would see them given, would serve to develop the chest capacity, and so improve the general health;* but I qualified my advice so far as to urge that there should be considerable limitation in the compass and severity of children's vocal exercises. This I did because I had learned from such high authorities as Dr. Stainer, organist of St. Paul's; Dr. Bridge, occupying a similar position at Westminster; and from others, that the number of boy choristers with fine voices who attain eminence as singers in after life is very small.

With larger experience, I would add that, not only should the compass of the voices be limited, but also that special care should be taken not to allow children to force their registers up too high. Regarding this matter, I am willing to admit that my former comparison as to the advantage of a child learning to sing early with that of a violinist, or pianist, was to a great extent faulty, or at least implied more than was warranted; for, supposing the voice of a boy to be very highly trained, the fact that the vocal organ undergoes a complete change, during the period of puberty, to a great extent nullifies advantages previously gained so far as the mere mechanical acts of voice-production are concerned. On the other hand, the fingers of the violinist or pianist merely develop, but never change in structure. These performers will, therefore, undoubtedly derive the greatest benefit from early training, and they have only to continue properly-directed exercises in order to obtain the highest degree of executive skill. So far, then, as mere mechanical expertness is concerned, the importance of very early vocal training may easily be exaggerated, especially in the case of boys.

As to the importance of absolute rest of the boy's voice at the period of "cracking" or "breaking" I have not a moment's doubt, and I have always upheld it in common with all who possess practical knowledge of the subject. At the risk of being considered combative, I cannot forbear recording my entire disagreement with the advice

* The reader is referred to a very interesting essay recently published by Mrs. Carlisle, entitled "Singing for Children" (Chappell & Co.).

of Dr. Morell-Mackenzie to the contrary, given in his recent lecture. He expressed belief that his statement would receive considerable opposition: I shall be astonished if such opposition be not unanimous; for the precept is, so far as I can judge, as utterly unwarranted by scientific fact as unsupported by practical experience.

With girls the change of voice with age is much more gradual and less perceptible, but even with them it is probably more beneficial that a comparative rest from singing exercise should be enjoined during the period of puberty. We are justified in this conviction by knowledge of the decided influence exerted by certain conditions of health on the quality of the singing voice in many females.

During passage of these pages through the press, I have received the following valuable letter from the distinguished musical critic whose name is appended, and, feeling sure that it will be read with interest, I print it intact:—

"My dear Sir,—In my opinion, the singing voice should not be used during the period of transition. My reasons are more empiric than scientific, perhaps; but as there is, even at the present time no definite information concerning the matter, such reasons are good enough, as they are founded upon the observations of generations, while a so-called scientific reason may be made upon the unsupported statements of inexperienced persons.

"The change of voice takes place in both sexes at a period varying from the twelfth to the eighteenth year. It is more marked in the male than in the female, though there have been instances in which the like disagreeable 'cracking,' arising from imperfect control over the vocal organs, has been as sharply marked in the female as in the male. This is especially the case with contralto voices.

"While the voice is in this transitional state, it is not only undesirable that the singing voice should be used, but it is impossible to use it with anything like an agreeable musical result either to the owner or to the hearer.

"I am of opinion, further, that the constant use of the voice in childhood, as in the case of choristers, tends to impair the quality in after-life. The best and most remarkable boy-singers rarely become good as men. There are, of course, numberless instances of eminent vocalists who have enjoyed the advantage of early training in church choirs in childhood; but in the majority of cases it will be found upon inquiry that they were not put forward as solo singers or made to sing passages of exceptional compass.

“The use of the voice in singing at this period of change ruins the organ for life. I do not pretend to offer any opinion as to the reason why the voice should be silent at this time other, than that it seems to me as sensible to employ the voice in this weak and transitional state as it would be to continue the use of a sprained joint, or to resume it before complete recovery of free action. In many persons the change is so gradual that they can and do sing throughout. Instances are on record of the treble voice being used continuously by young men up to the age of nineteen or twenty. For the remainder of their lives, those who do so have to be content with making music by means other than vocal.—Yours faithfully,

“W. M. ALEX. BARRETT,

“March 31, 1884.”

“Mus. Bac. Oxon, F.R.S.L.

In conclusion, I trust that the teachings of this essay have been indicated with sufficient terseness and distinctness not to require either summary or reinforcement. I will simply conclude by two quotations: the first from Dr. Wesley Mills, not only because it is in concord with what I have been writing for so many years, but because it is also interesting as an independent justification of my plea for more extended observance of science as a guide to the teaching of singing.

“There can be no doubt that the tendency of the age is to prefer force and startling effect to purity, correctness, and beauty of tone. As a physician, seeing a good deal of throat disease in singers and public speakers as well as others, I can most cordially endorse Madame Seiler’s practical philosophy as to the cause and cure of these complaints. *If the physiology of the voice were better known and acted upon, there would be but few complaining singers and speakers.*”

The second is from Herbert Spencer, whose plea for general physiology I quoted to begin with. In listening to what he says as to the capabilities of science to aid art, let us give no more heed to the cuckoo cry of the unscientific that art scientifically developed is of necessity in the least degree mechanical.

“We do not for a moment believe that science will make an artist. While we contend that the laws both of objective and subjective phenomena must be understood by him, we by no means contend that knowledge of such laws will serve in place of natural perception. Not only the poet, but also the artist of every type, is born, not made. What we assert is that innate faculty alone will not suffice, but must have the aid of organised knowledge. Intuition will do much, but it will not do all. ONLY WHEN GENIUS IS MARRIED TO SCIENCE CAN THE HIGHEST RESULTS BE PRODUCED.”

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