

errors are much less easily rectified in the latter region than in the former. This is the characteristic difficulty of the introspection method. Yet even our subjective experiences are found within certain limits to agree one with another, and in the multitude of observers there is an approach to objective certainty. And though it cannot be said that introspection has yet become a very perfect scientific instrument, it is to be remembered that it is a comparatively new acquirement of the race, which may be expected to gain in precision as evolution advances.

JAMES SULLY.

II.—OUR CONTROL OF SPACE AND TIME

PHILOSOPHERS have, as a rule, been so much occupied with inquiring into the origin and necessity of our notions of space and time, that they have generally passed over the somewhat humbler task of inquiring what are the nature and limits of our actual control over each of these entities. And yet it may be argued that hardly any inquiry can be of more importance from a speculative point of view; at any rate for the logician, whatever it may be for the metaphysician. For is not almost all the knowledge we possess a result of inference? and is not the result of inference generally reducible to, or at least expressible as, some real or imaginary change in our place or time? The wonderful complexity and ingenuity of the processes to which we have to resort, in order to attain to the aim as just indicated, tend very much in the case of most persons to obscure the real simplicity of that aim from view. But let us take a very simple example. There is a tree at the bottom of my garden, and I want to know how far off it is, and to what species it belongs. I can settle the former question roughly, in a few seconds, by pacing the distance, or with tolerably complete accuracy, in a few minutes, by the help of a measuring rod or line. The latter question is settled with equal ease, supposing of course that I have the requisite prior experience and knowledge to draw upon, by just going up to the tree and looking at its flower and leaves.

If however the tree happens to be on the other side of a river which I cannot cross, then I have to resort to calculation or inference for the purpose. Of course it would be much simpler and more satisfactory to go and look at the tree still, if I could only do so. But failing in this I have to set about 'inferring'. To decide the distance I appeal to some sort of trigonometrical

considerations; and to decide the species I gather up what help I can from the hints furnished by the size and shape of the tree, the time of coming into leaf, the colour of the flowers; or perhaps, if I am lucky, a bit of leaf or blossom may be blown within reach of me. But so great is our triumph, and so complete sometimes our success in finding elaborate substitutes for a simple walk or change of place, that we are very apt to overlook how almost ridiculously simple the end we aim at would often be, if only our faculties of locomotion were less restricted than they unfortunately are at present. There are myriads of facts about which if any doubt is felt it is dispelled at once by some one just going to look at the things; there are myriads of other facts, in all essential points often just as simple, which because unfortunately we cannot 'go and look at them,' task the highest powers of thought of our greatest philosophers, and the most exquisite skill of our instrument makers. If we want to know how hot it is at the Antipodes we go there ourselves, or send some one else there, with a thermometer. But if we want to know how hot it is half way there, *viz.*, at the centre of the Earth, or indeed whether it be very hot at all there, we are led into the most intricate questions of physics and mathematics, through which at present we can find no certain way.

Similar considerations apply also to the case of time, and, if possible, even more strongly; for here, for one reason or another, we seem to be more prominently occupied with the mere description of events (which is equivalent to their direct observation) and less on the whole with their analysis and generalisation. Very many of the facts which the ordinary historian toilsomely works out by elaborate comparison of records, and inference in filling up the gaps which they leave between them, are such as he could settle almost at once and completely to his satisfaction, if only he could just step back into the time in question. It may be replied that though he cannot go to the events the events can come to him, through the testimony of witnesses and other records. It is clear however that this one-sided process is a very poor substitute. The witness is not of our own selection: perhaps he does not know what are the important points which he ought to observe; and, one may almost say, he knows that he cannot be cross-examined, and is therefore subject to hardly any check. A few hours spent in personal observation upon the spot by a critical historian himself, would sometimes be worth a whole volume compiled by contemporary witnesses. This must especially be the case where we are concerned with general dispositions and tendencies rather than specific facts. People have disputed, and will continue to dispute, for instance, whether and to what extent our age is more moral than former

ages. What a light we should gain upon this point if only some London police magistrate, some doctor in general practice, or some shrewd man about town, could go, with proper introductions, into some other century, and live for a few months on easy terms with its inhabitants!

But many of the past facts which we want to decide can rest upon no personal testimony. We cannot appeal to the witness, because he was never there. And yet the facts themselves may be of just the same kind as those every-day phenomena in the decision and estimate of which any ordinary person is nearly as good a judge as any other. Such inquiries as whether the earth was once fluid, whether the glacial period prevailed more than once, and how far southwards it extended, are not in themselves more difficult of decision than to decide whether the lava from some volcano is fluid, or whether there are two winters annually in the Arctic regions. So far as any difficulties in the phenomena themselves are concerned, apart from our means of getting to know them where we are now, these questions could be settled at once by any witness as good as an ordinary skipper, without the least hesitation or doubt. He would merely have to tell us what he had seen and felt, and the matter would be set at rest at once.

The foregoing considerations are obvious enough when pointed out; and they would probably be perfectly familiar to every one, were it not that, as already remarked, the excessive ingenuity and complication of the various substitutes which have been discovered for the unattainable visit of observation tend to conceal from view the extreme simplicity of that end in itself. In saying this it is not intended to imply that the processes of inference at all resemble observation. On the contrary many of them are of a highly abstract and generalised kind, and they are mostly carried on more or less symbolically. But they ground or result in an imaginary observation. This is also the form which their concrete applications take, and we may fairly say that we have not attained a proper grasp of them until we can mentally reproduce them in this way. We must be able to individualise or picture the results to ourselves before we can be said properly to know them, and to do this is clearly to take an imaginary observation of them.

We may see then already how important would be a complete control over space and time, as for want of a better form of expression we have ventured to call it, for all purposes which concern our inferences. Any such control, if really complete, would tell at once by superseding all need for observation; for why carry on in our study a painfully elaborate and circuitous process when the direct process for which it was

meant to be a substitute was itself within our power? And indirectly it also tells in the same way by both strengthening and simplifying the processes of reasoning. The wider the basis of observation from which we start the better grounded, as a rule, are our conclusions, and the shorter the processes of getting at them. Every bit of extra power therefore that we could gain over these two all-pervading conditions of things would diminish the sphere and lighten the work of inference. Before looking closer at the details, let us just ask in a word or two what it is that we wish for; in other words, what are the requirements for that power of observation which if complete would render all inference superfluous, and which in proportion as it approximates towards completeness so powerfully aids our inferences? These requirements seem reducible to the two following—regard being had to the nature of our faculties and the general conditions under which we have to employ them: power to move about as freely as we may wish in space or time, and power to enlarge space and time to any extent we may need. The sense in which this latter requirement has to be understood will be more fully discussed in the sequel.

Let us begin with the former, *viz.*, our power of locomotion (the reader will observe that we are obliged to use, in many cases, space-words for time-ideas, and *vice versa*, from inadequacy in ordinary terminology). What our powers are in this respect, as regards space, every one knows. Within very small limits we can move ourselves, or the objects with which we are concerned, up and down and about, in three dimensions, as we please. Within wider limits, *viz.*, that of the surface of the globe, we are restricted to two dimensions. Beyond that again we are hampered still further by being confined to one dimension only, our motion along that even being quite beyond our own control. This of course refers to the motion of the earth round the sun, or any further motion that our system may have through space. Even this however, as an aid to knowledge, counts for something, so that we should not receive it without gratitude; for some of our knowledge of the shape and magnitude of the visible heavens depends more or less upon this power of linear movement.

But though every one knows the nature and limit of our powers in this respect, it is only those who have given some attention to psychology who can at all realise their importance in the processes of gaining knowledge, or the extent therefore to which our powers of inference are crippled by their very partial and one-sided development. Let us then take an example and look at it a little more in detail; and instead of beginning with some broad and concrete circumstance or aggre-

gate of circumstances, it will be better to commence with a minute one. I am inspecting some small object, say a penknife of unfamiliar construction, and I want clearly to understand its mechanism, size and shape. How is it that I am able to do this so completely and accurately? Mainly on this ground, that I am able to turn it about at will so as to present any face towards me, and to put it at any required distance far or near. With this, however, must be combined an important consequence of this power of adjustment, *viz.*, the power of looking at the same point of the object again and again as often as we please. This consideration is a very important one. My actual range of observation, as every one knows, is at any one moment extremely minute, almost indefinitely so, the merest point only being presented to the eye. But by running the eye repeatedly over the main outlines, by frequent recurrence to points already once looked at so as to bring them into connexion with the remaining points, we succeed in building the various parts up into one connected whole. We then consider that we have understood or taken the whole object in. To attain to this end it clearly does not much matter whether the power of local movement is on our side or that of the object, whether we turn about it or make it turn all sides to us. Motion being merely relative, either of these amounts to that control of space of which we are talking; and it is generally more convenient, when we can do so, to move the object rather than to move ourselves, for much the same reasons as make the turner prefer that the object should rotate under his tool rather than he be at the trouble of moving his tool round the object. But without this power of freely moving the thing relatively to ourselves or ourselves relatively to the thing, we should have extremely slight opportunities of getting familiar with the mutual arrangement of the various parts of any object small or great.

Now this state of powerlessness represents almost exactly our relation to events in respect of time. We are bound, as we all know, to go steadily forwards: we have no power to stand still, go sideways or backwards. It is easy to perceive how serious a hindrance is thus caused in our investigations. Suppose we are examining some small time-event. If it present itself in the form of some process which is entirely within human control we may probably be able to stop it altogether at some arbitrary point, or to invert its order of occurrence. This comes to very much the same thing as being able to turn the pen-knife over in our hands—in point of fact we are making use of our superior powers of space-locomotion and are substituting movement here for movement in time. The comparison therefore is not quite a parallel one; for it is not really the *same* event which we thus

turn about temporarily, but only an exactly similar one. It is as if we had no power to move our knife, but by looking about the room could observe any quantity of other knives differently disposed close by, but all exactly similar in their construction. We should thus contrive to supplement our impressions gained from one of them by those gained from the others. When however the operation under observation is a natural one, and therefore outside of our direct control, we are in general quite powerless to do anything of this kind. It is a very difficult thing to find what would popularly be called the 'same event' twice over—that is, two distinct events alike in all essential respects, but differing from one another by being each of them in exactly the desired stage of development. Different stages of development can often be secured readily enough, but they labour under the essential defect of discontinuity: that is, we cannot secure any desired exact intermediate stage at will: to say nothing of the obvious difficulty of securing that they shall really be alike in all other essential particulars. Suppose, for instance, we are examining the process of germination of a seed. We may find it the best plan to grow a great many of them, and then select some of them for examination, thus securing that there shall be some of them in almost all the successive stages of development. But this seems to fall just as far short of what we really want as would an offer to look at a variety of knives, very much like one another, lying in various directions about the room, but without permission to stir from our position or touch any one of them, fall short of the advantage of handling any one of them at leisure, and turning it about into any desired position. What a gain, for instance, it would be to any student, say of embryology, if he could put his object under a microscope and then shift it a few minutes or hours forwards or backwards in time according to his choice! Forwards of course he can go, or rather must go, as things are now, provided the processes in question are not brought to a stand-still by means of the observation itself. But apart from the tedious uniformity of the pace with which that progress may now be carried on, there is the fatal defect that we cannot pause at the critical stages, and recall and re-observe them at our leisure. What we want is the power to stop still and to go backwards whenever we please. Compare the position of a man who has got an intricate argument in writing before him, with that of one who can merely listen to it as it is repeated to him in order, and we shall realise the difference between what our powers of observation now are and what they might have been had these things been other than they are. What we want in fact is a microscope with a double set of stage-screws; one set to move the stage about as is now done,

in respect of space, and the other set to move it about in a similar way in respect of time. A very small range of such movement would answer our purpose. Many an intricate question which has puzzled physiologists and others for years, might then probably be cleared up in a few minutes; for no one needs to have it pointed out to him how much easier it is to keep the same object continuously in view under a slow movement of any kind, than it is to detect and recognise it, or rather something else very much like it, amidst a crowd of varying circumstances which only permit an occasional glimpse.

Physical speculators have not unfrequently indulged in fanciful modes of attaining the equivalent of such a power as that just indicated. Since light travels with finite velocity, we are at liberty to conceive an object moving so fast as to outstrip it. Suppose a human eye receding from our system into space with a velocity greater than that of light, and occasionally pausing for a moment so as to permit the rays from the objects which it was leaving behind to overtake it and record their impression. We should then invert, so far as that eye was concerned, the relative course of events, and this would be, so far as all visual considerations applied, precisely that regression into past time which is desired. Doubtless the object in question would thus become diminished in size, and perhaps dimmed in brightness, at a most prodigious rate. But in spite of this it might still be possible thus to make out certain features such as the change of colour in some of the fixed stars, or the relative change of place in some of those which were double. Sound waves of course travel with far less rapidity; and accordingly similar considerations, though leading here also to very wild fancies, do not yield quite so wild fancies as those involved when we try to meddle with light. Projectiles from some of our great guns actually do outstrip the sound of their discharge. If therefore one of these were gifted with an ear and the requisite consciousness, the first thing which it might hear that in any way concerned itself, when it had come to rest and recovered itself, might be the noise of its flight through the air, followed by the sound of its own discharge, and finally by the word of command to discharge it.

But power to move about as we please in space or time is clearly only one of our requirements. Suppose we have succeeded in placing ourselves right opposite to the thing, or contemporaneous with the event, it may still be too small, or too brief, or possibly too large or too slow for our purposes. Observation is conditioned by the nature and limits of our faculties, and it is no good being in close proximity to a thing if our faculties are unable to take it in. One great difficulty

consists, it need not be said, in the fact of the phenomena needing magnification; in their being, that is, too small for observation. Abstractedly considered, therefore, the alternative before us, as regards this desideratum, is either to make the thing itself really or apparently larger, or to make ourselves smaller. It would often be highly convenient to us if we could succeed in the latter object (for what opportunities of observation, concealed from us, the minuter insects must enjoy; and how much they could tell us about the constitution of various bodies—cell-structure and so forth—if only we could strike out some means of communication with them!). Failing this, however, we have to resort to the former plan, *viz.*, that of making the thing bigger. But here popular language, and not improbably popular thought also, is somewhat confused. We do not actually magnify objects; that is, enlarge their real dimensions in space. At least we do not do this intentionally and for purposes of observation; for the change thus producible, though real as far as it goes, is far too slight to be of any practical service. Heat an object, and of course it grows larger; and its various characteristics are, to that extent, more easily decipherable. But whatever may be the importance of taking into account such considerations as these when we have to deal with large iron constructions, such as railway bridges, &c., no one would think of appealing to them to furnish any practical aid in our processes of observation. What therefore we have to do instead is to enlarge the effect which the object produces upon us; that is, to enlarge what we may call the image which it produces upon our organs of sensation.

When we thus shift the proposed alteration of size from the object itself to the effect produced by it upon our various senses, we have at first sight an apparent promise of riches which is by no means fulfilled in practice. For we possess a variety of senses, and it might be suggested that we should take each of these in turn and magnify the impression which we obtain of an object by means of it. But any such hope is soon seen to be illusory. To begin with, only two of our senses give us much service in the way of estimating space-relations—*viz.*, sight and touch; the other senses being of very little use in this respect. And moreover, as it unfortunately happens, one of these, *viz.*, touch, has proved itself quite incapable of any such refining process as we have just now in view. Hence it comes to pass that our sole reliance in this respect has to be based upon the sense of sight.¹

¹ It need hardly be said that we are here speaking solely of *direct* appeals to sensible testimony. Of the many indirect methods which are available,

What we can do in this way as regards space has been rendered familiar to almost every one, for nobody with any rudiment of cultivation can have failed to often handle a telescope or microscope. Accordingly we need devote but very few words of explanation here, and they will only be expended in order to draw attention to, and render more simple, the less familiar parallel application to time. Now if any one were asked, taking the current signification of the word 'magnify,' whether we can do the same here for time that we can for space, what would he probably reply, as soon as he had realised the nature of the question proposed to him? Most likely he would give a decided negative; and, if asked his reasons for saying so, the instance of the microscope would very probably furnish the most appropriate example in illustration. Every one who has ever had to look at living things through a microscope will be aware how much their apparent motion is affected thereby. He will be familiar with the curious rapidity with which the smaller organisms, animal or occasionally vegetable, shoot across the field of view. They move apparently with extreme velocity, so that we have sometimes to deaden them, or at least to do something to hinder the vivacity of their movements, if we want to secure a sufficiently steady look at them. This apparent velocity may of course be explained by saying that we have magnified the interval of space through which they move, but have not altered the corresponding intervals of time. Hence of course the velocity which depends upon the ratio of one of these elements to the other, has been made apparently much greater than it really is.

Such an answer is abundantly sufficient for all practical purposes, but as we happen just now to be almost wholly in the regions of speculation rather than in those of practice, it will be necessary to look a little more closely into the matter. We must ask again then, what exactly do we do when we magnify an object? As every one who has any acquaintance with optics is aware, all that can be secured by any combination of lenses, whether they take the form of telescope, microscope, or opera-glass, is an enlargement of the area on the retina which is occupied by any minute part of the object presented to us. So far as we are concerned this comes to just the same thing as if the object itself were actually enlarged; it being of course insisted on that every element of the object shall be similarly treated, so as to prevent any kind of distortion.

This, it will be observed, concerns only the sense of sight. As already remarked, the sense of touch cannot be aided by any

such as resort to more refined measurements, employment of electricity substitution of time for space in measurement and *vice versa*, and so forth, we here take no note.

corresponding process of assistance. This is greatly to be regretted, for the gain to our knowledge would be enormous were any resource of the sort available. For instance I look at a pebble and at the same time I handle it. The two senses co-operate here, the sight and the touch; the latter being in many respects the most powerful and trustworthy of the two. Either by itself would be fallacious and easily misled, but taken together, so as mutually to aid and correct one another, they concur in making up our information about the object. But suppose it were some microscopic object, say a diatom instead of a pebble, which was under our observation. What an immense gain it would be if I could handle this also on a larger scale, with the same success as I can look at it on a larger scale! Questions which have often puzzled observers, for instance, whether certain marks upon their surface are ridges or not, would then be instantly set at rest. The case however seems hopeless, even to the imagination, which is saying a good deal—for the deficiency arises out of that which constitutes the main excellency of the sense in question. The difference consists of course in this, that we see by means of a medium, and it is this medium of which the microscope is able to make use for its purpose. But in touching the object we come into direct contact with it (all metaphysics apart), and there is therefore no available means by which the subjective effect can be made more delicate in the way desired.

Now let us turn to *time*, and see what there is here, corresponding to the same state of things. To begin with, can we actually magnify a thing—or rather an event as it would be more appropriately called—that is, can we make it take a longer time in happening? Of course we can, and to a very much greater extent than was possible in the corresponding case of space. We must of course remember that what was demanded in the former case was not merely enlargement in general, but uniformly proportional enlargement throughout. So what we want here is uniform diminution throughout in the speed with which the process is performed: otherwise we should be hindered by what may be termed time-distortion or warping. A moment's reflection will remind us how very frequently we can secure this end, at any rate to some extent. When we are dealing with time it is events or processes, rather than things, with which we are concerned, and many of these may consist of our own performances. Most processes over which we have any sort of control can be gone through more or less slowly, and some of them can be performed just as slowly as we please. And, what is very important, we can make sure that the second performance is so exactly the repetition of the former, except in

the point of speed, that we can really speak of it as being in popular language the 'same' event over again. These remarks apply especially to the cases in which mere motion is under consideration; as if, for instance, we wished to observe the exact path traced out by a point on a swiftly moving wheel, or the mutual relation of the different portions of some complicated machine. But when we come to considerations of force and have to reckon with mass and gravity, even in the simplest kinds of action, we lose much of this control. If projectiles could be made to move as slowly as we please, men would not have remained so long in doubt as to the nature of the path traced out by them; nor would artillerists even now be uncertain as to the direction of the axis of an elongated shot during the course of its flight. If a horse could be trotted or galloped as slowly as we please we should instantly be able to settle the vexed question as to how many legs he has upon the ground at one and the same instant. But, after all such exceptions, this particular power over time is greater than that over space. When it is merely a question of making a thing take place more slowly we can often succeed in doing so to any extent we please, without the slightest fear of producing distortion.

But, notwithstanding this, when all is done that can be done, there still remains a very large field of events quite beyond our own control, and in which the rate of change is so great, or the time occupied so short, that our powers of observation are altogether baffled. In these cases therefore we sadly need some instrument, corresponding to a microscope, which shall be contrived so as to diminish the rate at which the successive brief and rapid changes in the stages of an event reach our organs of sense. Transferring the language appropriate to one order of considerations into the domain of the other, we may say that the power of magnifying a few thousand diameters in time would often be of enormous service to us. It would make the greatest possible difference to us in the ease and accuracy of many of our observations and consequent inferences about very brief or very rapidly changing events.

Can we then succeed in attaining any such power of magnifying? Before attempting to answer this question we must first see which of our various senses are most in employment in estimating time-successions, so that we may know which they are that need such assistance. In the case of space we saw that of the two senses principally concerned in yielding information one only had shown itself amenable to this magnifying process, namely the sense of sight. In the case of time the senses upon which we have most occasion to rely are, it seems, those of sight and sound; for touch and the muscular sense do not play any

important part here, at any rate not in the simple examples now before us. Let us begin then with the former of these, and trace out in an example the nature of the analogy before us. Take for comparison some very minute object, say a pollen grain, and some very brief event, say a flash of lightning. What we do with the former is of course to enlarge the angular magnitude which it subtends upon the retina, so that the eye may be able to distinguish the space attributes of its various parts. In simple words we make the object 'look bigger'. What therefore we want to do with the latter is to enlarge the time intervals occupied by the successive portions of the event as they reach the eye. In equally simple words with those above, though, owing to the unfamiliarity of the conception, they do not happen to be words in common use in this exact signification, we want to make the event 'look slower'.

The former of these objects is happily secured by the invention of a system of transparent lenses which spread out the rays of light in space. Can no sort of glasses be contrived which shall spread them out in time, if one may use such a phrase? Unfortunately not, so far as we know; though there is nothing which need deter the scientific imagination from trying to conceive the existence of such a contrivance. It really does not seem as if we had to do more than postulate the existence, in an extremely high degree, of qualities undoubtedly possessed in an extremely low degree by various substances at present. It is a well-known fact that light travels less rapidly through dense glass than through that which is rarer. Take then a sheet of glass of which the density increases uniformly from one end towards the other, and look at the flash as it passes across the pane. Let the increase of density at one end over that at the other be only sufficiently great, the transparency being retained unaltered, and the desired effect will be secured at once; for the whole duration of the flash, and that of each portion of its career, would be proportionately lengthened out. If we could effect in this way a second of delay in the passage of the rays through the thickness of one end of our sheet of glass, over that occupied in their passage through that at the other end, and if the whole duration of the flash was the 10,000th of a second, we should have secured a magnifying power of about 10,000 diameters, so to say. If the momentary event was comparatively stationary in space, like the flash of a gun, say, instead of lightning, then we should have to move our glass before it, instead of leaving it to move before the glass. The introduction of such a delay as might thus be conceivably brought about would be enough to enable us to ascertain tolerably plainly the shape of the spark or flash throughout its career. As we are not describ-

ing such an instrument but merely suggesting that it is not inconceivable, we have no need to suggest also any remedies for various obvious difficulties. All that we need say is that, always granted the first step, they possibly might not prove proportionately more intractable than the difficulties of aberration and spherical distortion which at first seemed absolutely insurmountable difficulties in telescopes and microscopes.

To 'magnify' for the ear we should need a slightly different contrivance (we are still discussing of course the prolongation of the sound, not its intensification in the way of loudness). It may possibly be suggested that magnification of the kind in question is already sometimes secured for us by nature; for is not a thunder-clap really a momentary crash which has been lengthened out into a continuous roar before it reaches our ears at a distance, owing to the multitudinous reflection from many clouds? A little consideration will show however that the analogy here is not a valid one. The thunder-clap is not really changed into a single prolonged one. What takes place is rather this: it is changed into a great number of equal ones rapidly succeeding and indeed overlapping one another. It is as if instead of using a lense in order to get one enlarged image we employed a sort of multiplying mirror which produced a great number of closely adjacent and slightly superimposed images. This of course would give a larger resulting image, but it would be merely a blurred one and not at all the enlarged and clearly defined one which we wanted. A real magnifier would have to produce a single aural image of which the component parts shall merely be enlarged, and proportionately enlarged, but none of them repeated more than once. How should we set about the construction of such an apparatus? Construct, as before, a diaphragm which at one end shall be (acoustically in this case) less transparent than it is towards the other end. We should then need some kind of tube, itself impervious to sound, and the diaphragm would have to be moved rapidly across the end of the tube which was towards the noise in question, whilst the ear was applied to the other end. Each successive minute interval of duration of the sound would then be equally retarded, or 'magnified,' and might thus become perceptible and distinguishable by the ear. The *tone* of course of the noise would be altered, but for this allowance would have to be made after due calculation.¹

¹ The importance of such an end, unattainable as it may be, is aptly illustrated by the phonograph. That instrument, as is well known, will imitate and reproduce sounds, say those of the human voice. Inasmuch as it does so by the turning of a handle we can of course turn that handle as slowly as we please, and thereby obtain a control of the speed of utterance

The above remarks belong mostly to the region of dreamland, but they none the less concern a subject which all who have occasion to speculate on the nature of Observation and Inference ought to be familiar with. Even in the most mechanical employments, and under the strictest confinement to practical aims, a man will never truly understand how his machine is working within its ordinary range and conditions, unless he also knows what it would do under conditions which he will almost certainly never see realised. Even then our knowledge can never be sound and accurate about what does happen under present conditions unless we make it embrace also a good deal about what merely might happen under conditions which do not exist. When therefore we are professedly dealing with speculation rather than with practice, the necessity of thus freely extending our limits of thought and hypothesis becomes quite imperative. Our observation and inference are carried on under certain conditions of space and time. Some of these conditions seem absolutely inseparable from the very nature of our faculties, and I will therefore leave to the metaphysician the discussion of what would come to pass were these tampered with. But there are others amongst these conditions (referred to here, for want of better terms, as 'our control of space and time') some of which are within our power to some small extent to modify and amend. With the nature and consequence of these the logician is bound to render himself familiar, both as they are now and as they may be in the future; but he will never succeed in doing this unless he is also familiar with them far beyond this point, *viz.*, as they are conceivable to the imagination but will in all likelihood never be realised at all in practice.

J. VENN.

III.—M. RENOUVIER'S PHILOSOPHY.—LOGIC.

I.

PHENOMENISM in some shape or other bids fair to be the philosophy of the future. Kant's Critical Philosophy impressed, as is well known, its direction on succeeding thought, and in fact has dominated its development down to the present day. Of the two strains which contended for the mastery in Kant, the

of the machine which inveterate association forbids in the case of our own vocal organs. This, of course, is a perfectly distinct process from that conceived and discussed above. It corresponds (in the case of space) to the physical enlargement of a body already alluded to, as distinguished from its being what we call magnified.