

## OBSERVING OR GAPING: WITH INFORMATION CONCERNING CONJURORS, CAREFUL EQUILIBRISTS, CENTRES OF GRAVITY, AND CIRCUS GIRLS.

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IT is very disturbing to think. By far the most comfortable way to get through a lecture or class period is to let the master talk without listening to him consciously, so that he merely provides a pleasant background of sound. When you are required not merely to suffer him to talk at you, but also to consider and remember what he says, it becomes mentally fatiguing; the less there is of importance in what you hear, the less you have to consider; and a good master remembers that when he talks to you for a whole class period, then, although he may ask you later for an abstract or a *précis* of what he has said, his whole talk should not itself be an abstract. There is a limit to the amount of concentrated listening and thinking that we can manage over a given time. One can present a talk that is a concentrated dose—a *précis* in itself; or one can dress up two or three ideas so that the talk is like a Pomeranian dog—mostly fluff and very little body. The fluff must be looked upon as necessary—Pomeranians would lose their value if skinned, having then not even the economic importance of a rabbit; and similarly, if a talk or an article has no “fluff”, you merely gape and fail to follow it, so that probably the whole time is wasted.

You possibly approach a lesson which does not interest you, from some person who frankly bores you, as some people prepare themselves for a sermon in church—settle back as comfortably as you can under the unfavourable conditions and prepare to think about something pleasant. It is the teacher’s job to pad out the matter which he presents, and so to present it that you will be sufficiently interested to concentrate on what he is saying, so that you will not merely be *gaping* at him whilst pretending to look intelligent whilst thinking about something of greater interest to you personally.

198. When a master is merely muttering happily to himself whilst he draws pictures on a blackboard, or when he reads tranquilly from a book or from his notes without occasionally pouncing with a question, then you do not endeavour to concentrate.

You can let your eyes wander so that you see a number of different things. Bill Jones is continuing the manufacture of a paper aeroplane, Jack Thomson is making qualitative observations on surface tension (or rough quantitative observations) by watching how far the ink is "sucked up" a stick of chalk when he dips it into the inkwell, the teacher in charge is discussing the subject with the bright boy of the class—lots of things are happening. In another class-room, if your name be Clarice instead of Clarence you may note that Marjorie Smith is getting on slowly with that jumper she is knitting, that Dorothy Perkins's plaits are coming undone, and that the teacher has not had the opportunity of powdering her nose since lunch time.

You are just pleasantly relaxed, you switch from sight to sight so that you merely see things without bothering to think about them, and, after all, half an hour will soon pass. You are merely gaping, even if afterwards you were able to say how everyone looked and how everyone appeared to spend the period: Above the animal plane, because you cannot help it, and do occasionally observe, and note cause and effect, possibly even make deductions from your observations, during your gaping. Very restful.

You don't rest when you go along to the theatre to see a conjuror. You are keenly observant of his doings all the time. He performs a trick; you know it is a trick, and try to see how it is done. He performs it slowly again—"Now, just watch me; there's nothing in this trick, if I do it slowly like this you'll see at once how it is done, and be able to do it equally well yourselves with but a little practice. I merely take this ordinary egg in my hand"—he drops it, apparently by accident, on to the table, and it makes the usual nasty mess. He apologises for his carelessness, and takes another egg from the same dish. "Well, I take this egg in my hand, and I gently squeeze it so, and *presto*—it has vanished." He then fires a pistol up into the sky and down drops the egg, which he catches in his hand,

and which is identified as the original one by the fact that it has a rising sun stamped on its top. You don't merely sit back and watch all these things happening without observing. You are no longer merely gaping. This is certainly *not* a restful performance. The man is doing tricks—or, he is performing experiments, and is withholding from your knowledge a lot of the experimental facts. There are gaps in your information, and you try and deduce what those gaps may be, reasoning from your earlier everyday experimental knowledge. That is very similar to what is happening in science—we observe an experimental fact, which is new to us. We try and explain it in terms of experiments with which we are already familiar. It is very seldom that we are able to watch all the intermediate steps. If you watched the conjuror very carefully you might observe that everyone's attention is momentarily attracted to, say, a pretty girl coming on to the stage from the wings, and that whilst the whole audience instantaneously glances in that direction, he places the egg back in the dish. I am not saying that is what happens here—it is merely a *hypothesis* I am putting forward, and a hypothesis is only a tentative explanation, to be tested by fresh observations. But the dodge of "temporary distraction" is frequently adopted by a conjuror, so that you cease to *observe him* for a moment.

It is unusual to gape whilst at a conjuring performance—very few people, even amongst the girls, are content to sit merely to watch the rabbits and pretty ribbons coming out of a small hat. You are not content merely to come home and state what you saw happening. You have made *some* observations—that the hat was far too small to contain four rabbits, half a dozen ducks, five inflated balloons, and hundreds of yards of ribbon. That when the girl was freely suspended in space you couldn't see any supporting wire. That when the conjuror touched a man on the head with his wand and a jet of water shot up and continued to play, the man walked freely about the stage, and you couldn't see any pipe connected to him. Undoubtedly, conjurors are very tiring people, and if we were compelled to watch them day after day all our lives, we would pass long periods when we merely gaped at them, or during which we merely settled ourselves back and tried to think of something more interesting.

Nature is a conjuror, and we are present at the performance throughout our lives. Tricks which we consider now to be very ordinary, and tricks which we still cannot explain, are being performed around us all the time. Is it any wonder, then, that we tend to gape for portion of this long continued performance? Is it any wonder that we fail to maintain a continued *observation* of her tricks? Is it any wonder that we get tired of trying to find out how her tricks are done so that she will permit us to see more difficult tricks which will be harder for us to explain? (Those are what are called rhetorical questions, to which you are not expected to reply.) But it is remarkable that so many people are content to sit through the whole of life's performance as gapers. *In science, we train you to appreciate the performance of the great conjuror.* The primary lesson of science is to observe—the lessons of the subject are so fundamentally important that ultimately every child in the civilised world will receive an elementary training in general science, far more advanced than you receive now. Apart from all the principles and laws, units and definitions, which you are taught, you should learn to *do*, to *note*, and to *think*.

Let us now go to the circus. I'm always interested in the people who call themselves "equilibrists"—that's how they are spelt on the programme, and how the ringmaster pronounces it, anyway. They are people who balance, or maintain themselves in equilibrium, either individually or in groups, under all sorts of extraordinary conditions, and in all sorts of places. Two of them stand on and within a very large hoop suspended about thirty feet up in the air. Another one leaps from a trapeze, and poises, upside down, with one hand on a shoulder of each of the other two, so that they are balanced as a set of *three* people, one inverted, standing on the feet of *two* of them, on a hoop high up in the air; the hoop itself is then set swinging, and they sway with it. Very clever and very exciting, particularly when they pretend to lose their balance and fall, to catch the hoop at different parts, and then to be lowered with it to the ground.

There is also the man who balances a rod on his forehead and then throws up a billiard ball which he

catches with, and balances on, the far end of the rod. And the plump girl in spangles who stands on the beautiful white horse whilst it gallops round the ring. She also jumps through hoops as the horse gallops, and we are pleased to see her meet the horse successfully again on the other side of the hoop. We are still present at a conjuring exhibition—there is no magic, either, in the performance of the conjuror or of the equilibrist, though, because we suspect the conjuror of attempting wilfully to deceive us, we rather tend to observe his performance whilst merely gaping at the equilibrists. How can they do it?

Get up and walk about. (Not now—that also is rhetorical.) When you stand on your feet, or when you walk about, you are performing a wonderful balancing feat which your parents can assure you took some time for you to learn; but it is the kind of balancing feat that is performed by most human beings without thought, and so we do not think it in anyway clever. Well, how *is* it done?

We can determine the position of the centre of gravity of a body experimentally: “It is, that point through which the line of action of the total weight of a body always acts, no matter in what position the body may be placed.”

Instead of dealing with the weight of the body distributed throughout a large volume, we may imagine it concentrated round that point, the centre of gravity of the body, for purposes of calculation. As you know, to determine the position of the centre of gravity of a body you hang it up by a cord attached in turn from different points on the body, and allow it to come freely to rest. The vertical line continuing the line of the cord downwards always passes through the centre of gravity of the body, so that by making several suspensions you get several intersections of the different lines of the vertical through the body. The common point where they meet is the centre of gravity of the body.

I don't know precisely where my centre of gravity is—and it is variable throughout a small volume as I alter the positions of the weights which go to make up my body and its contents. It is inside me, about a couple of inches in front of my backbone, and just above the

equator. So that instead of considering my total weight spread out over what amounts to a large volume, I can consider myself, so far as weight is concerned, as concentrated at my centre of gravity; if I hold my arms out horizontally in front of me, I alter the distribution of my body, so that the centre of gravity would move forward a little bit; if I hold my arms out behind me, then the centre of gravity of my system moves back a little.

When a body stands on a surface without falling over, and without any other support than the reaction of the surface on which it stands, then we know that the vertical through the centre of gravity of the body must pass through the area of contact between the surface and the body. Suppose I stand a lead pencil up on its flat end on a table. Then the centre of gravity of the pencil will be about half-way up it, and at the centre of its circular cross-section; if the pencil stay in equilibrium, that is, it does not fall over, then I know that a vertical dropped through its centre of gravity will pass through the little area of contact between it and the table. It doesn't require much of a push to move the centre of gravity to one side or the other, so that its centre of gravity is *not* vertically above its base. Then it *must* fall over.

We have learnt the clever trick of keeping our centres of gravity vertically over the area of contact of our feet with the ground. We don't even worry about it. A toddler will get up, sway a bit, and fall over. You and I merely stand up, and by unconsciously exercising muscular control, so dispose the jointed bone system, covered with meat and fat and threaded with tubes through which flow liquids, that forms our bodies, that we keep the centre of gravity of the system vertically above the base of contact of our bodies with the ground. I can stand on one foot, and automatically so dispose my body that then my centre of gravity is vertically above that one-sixth square foot, which is the area of contact of my shoe with the ground; if I stand on my two feet close together, then my centre of gravity is to be kept vertically above that area of contact of about one-third square foot; if I "stand at ease", with my two feet apart, then I can lean right over till my centre of gravity is above my right foot, or right over till

my centre of gravity is above my left foot, without losing my equilibrium and falling—quite a big sideways adjustment is thus permissible, and the position is more comfortable—the centre of gravity now merely having to be kept over or between two separated areas of contact. I must be careful not to sway so far forward or so far backward that my centre of gravity would be vertically above a line ahead of my toes or behind my heels. Suppose my feet were tied tightly together, and that I was standing on them: then I would merely continue to perform my trick of keeping my centre of gravity over the one-third square foot contact between my shoes and the ground—a fatiguing job, because one is unconsciously working all the time, exercising muscular control to overcome the instantaneous “falls” in one direction or another. Supposing someone now tied a heavy load on my back, I would lean forward whilst they were doing it, so that the centre of gravity of that combined system of me and load should still be over my feet; if, instead, they made me hold a load in my arms, I would then lean back a little bit. Suppose inadvertently I *momentarily* let the vertical through my own centre of gravity, if I am not loaded, or through the combined centre of gravity of me and the load if I am loaded, fall outside the area of my feet; then I must fall. I cannot recover my equilibrium and would continue to rotate until I lay or sat on the floor—having now a big area of contact, within which the vertical through the new position of my centre of gravity would pass.

Suppose that my feet were still tied together, and someone gave me a little push. I automatically alter the distribution of my body so as to keep its centre of gravity above the feet-area; if I am pushed so far that my centre of gravity is no longer over that area, then over I topple.

My feet *not* being tied together, then if, say, pushed forward so that my centre of gravity would lie ahead of my feet, I correct that by putting a *foot forward* at once, and so preserve the necessary condition for equilibrium.

I remember one sergeant-major drilling soldiers in “physical jerks”, as they used to be called. Do you know the exercise, “Left leg sidewise—*raise*”? You stand with your feet together, and your hands on your hips, and

on the order, raise your left leg slowly out to the left as far as you can. This sergeant-major was always very annoyed with, and even discourteous to, those men who leaned far over to the right to maintain their balance, and used to yell at everyone *not* to move the body at all, only to raise the leg. Of course, if you push a large lump of yourself out to the left, you must push either your whole remaining portion a little to the right, or a little of it a lot to the right, to keep your new centre of gravity over your right foot, now alone left in contact with the ground. Try it afterwards for yourselves—first, left foot raise whilst letting your whole body sway over to the right. Then repeat it, seeing how little you need move your whole body. Then, thirdly, in case you don't think you move your body, stand with your right side and leg hard up against a wall, so that you can't sway to the right by much. Now try and do "Left foot—raise".

Now stand straight up, feet together, hands by your sides. Bend forward till the upper part of your body is horizontal. As you are still in equilibrium, your centre of gravity must still be vertically above your feet. But you have obviously thrust a big portion of your body ahead of your feet—so that you must automatically have compensated by sticking an equally weighty portion back behind your feet, thus keeping the centre of gravity still above the feet. You can check this also by trying to do it whilst standing with your back to a wall, your heels being close in to the wall. You can only lean forward till your centre of gravity moves forward from its usual position of over a line through the heels to being over a line through the toes. Bend a little more forward, still refraining from bending your knees (or taking your legs away from the wall of course), and the vertical through your centre of gravity will come ahead of a line through your toes, and you will rotate about them and fall unless you restore equilibrium by putting forward a foot.

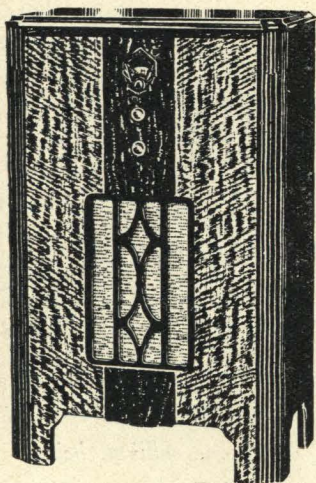
Equilibrists are people who are skilled in keeping their centre of gravity, or the centre of gravity of a system of which they form part, in the right place. We are physiologically adapted to do that without any great difficulty, so that it is merely a matter of practice for you to pass on from your present universal trick to



those at which you used to gape at circuses. Next time you see them, don't gape at them, observe them.

I could tell you a lot about the tricks of the plump girl in spangles who rides the white horse, but I am afraid I will not have the time. She is, of course, an equilibrist, and when she stands up without holding on whilst the horse canters round the ring, she has to contend with the experimental fact that the movement of the horse is not uniform. You stand and do your simple balancing tricks on a horse—the world—that is moving uniformly. It is galloping in its ring round the circus master, the sun, at more than sixty thousand miles an hour. It also revolves as it goes—a bad habit that the white horse shares without being aware of it—so that you are twirling with it about its axis at up to one thousand miles an hour; and there are other steady movements besides those. Your bodies are part of the matter of the world, and have always had those uniform movements—there are no fresh ones being impressed on you from instant to instant. Suppose you stand on a ship or a train which is proceeding perfectly smoothly and not rocking, or pitching, or swaying—then once you get going, you share the uniform speed of your vehicle, and do not notice any difficulty in preserving your equilibrium. But if the vessel is tossing or pitching, or the train rocking and jolting, then those changes in motion have to be transmitted to you as pushes, through your feet, your feet being moved suddenly in one direction whilst your centre of gravity momentarily remains where it was—so that momentarily the vertical through it falls outside your feet, and you stagger. A sailor has learnt to adapt himself to the movements of the ship, as has an engine-driver to the movements of the train, so that they adjust the positions of their centres of gravity more rapidly than do you. Similarly, the equilibrist on the horse adapts herself rapidly to the changes in movement which it impresses on her.

As I said before, *everything* going on is interesting if we *observe* it. We lose much of that interest if we merely *gape*. It does not detract from the beauty of a sunset if we want to know why we see the glorious medley of colours; nor from the flavour of a fruit to know how scientists have laboured to give us the many improved modifications we enjoy today, and to what particular chemical each dominant flavour is due.



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