Primer on cause - effect

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Philosophy 207: Metaphysics[1]

1) Causality is not observable

We observe things happening all around us; things undergo changes in all kinds of expected and unexpected ways. But notice that we don't ever directly observe the important connection between things we call cause-effect. Take a moment to reflect about this, for most people don't realize that no one ever actually observes causal connections between things. You see something happen and then see something else happen. For example, while driving you step on the brakes and then experience that your car slows down, or you feel the knife you are using slip and cut your finger and then you feel pain and see blood come from the cut. But you don't actually see the special connection we call "cause-effect" between braking and slowing down, or between the slip and the cut and then the pain and bleeding, or between anything and anything else. Rather you "understand" or "conclude"– based on (1) certain metaphysical assumptions about the way things in our world must work and be related, and (2) what you observe (plus your memory of similar observations) – that one event is the cause and the other event is its effect. That is, you bring to the situation a general belief that there is a cause-effect connection between some things and events and other things and events in our world, (and, by the way, you also have a general believe that there is no cause-effect connection between other things and events in our world), and then you apply this metaphysical belief in cause-effect connections to what you observe (e.g., braking and slowing, cutting and bleeding); but note carefully that no one ever observes the cause-effect connection itself, we just see things happening at various times and places as we go about our business.

2) What we believe about cause-effect connections

You don't apply the idea of cause-effect to just any two events. Why not? Because we commonly believe that there is some underlying reality that must be taking place for our application of cause-effect to be justified. I'm sure you realize how important it is to apply the connection of cause-effect to the right situations – for example, important practically for getting things done and for advances in technology, important for

understanding how our physical universe works, and important for assigning blame to the people we believe are responsible for causing harm.

There are two issues to look into: (A) what we mean by cause (what does this idea involve and how many ideas of "cause" are there?), and (B) what might be going on in reality that makes it right, makes it justified, to apply this idea of cause-effect (sometimes we get this wrong and think something is causing something else when it isn't). But first let's address a vocabulary problem. The problem is that in English there are many common expressions for cause-effect that don't actually include the words "cause" or "effect". Here are just a few of the more common ways of saying "X causes Y":

-- X makes Y happen
-- X yields Y
-- X is responsible for Y
-- Y is affected by X
-- Y comes from X
-- X is the reason for Y
-- X creates Y
-- Y is the result of X
-- X influences Y
-- Y is due to X
-- X explains Y
-- X is the source of Y
-- Y happens because of X
-- Y is the product of X

Some of these common expressions are clear; they are just another way of saying X causes Y. But others can be very misleading, especially these three: "responsible," "because" and "reason." Take the expression "X is responsible for Y." This often means X causes Y, as in "drunk driving is responsible for many traffic fatalities." But in the fields of law and morality it might mean X (a person) is legally or morally responsible for Y (something bad) even though X did not cause Y to happen. For example, if you knew before 9/11 that terrorists would crash planes into the Twin Towers and said nothing about it, you would be held morally and legally responsible (to a degree that you could go to jail!) for that terrorist attack even though you did not cause this terrible thing to happen. Or, if a wife knew that her husband was sexually abusing their daughter and did nothing about it, she would be held morally and legally responsible for the abuse even though only her husband was doing (causing) the abuse.

Next, take the expression "Y happens because of X." This often means Y is the effect of X, as in "the house still smells of smoke because of last year's house fire." But when we reason and form an argument to support a belief, or offer evidence to someone to get them to accept a belief, the term "because" is commonly used in a way that has nothing to do with causality. For example, if you wanted someone to believe a house is on fire, you might say, "there must be a fire in that house because of the heavy smoke coming from it." This does not mean the smoke causes the fire – it would be wrong to think this, for it is the other way around – it means that the smoke is evidence, a good reason, to believe that the house is on fire. So, in English the word "because" can mean cause-effect or it can mean reason, and these two important concepts are not the same and should be kept distinct; it causes a lot of confusion that both are expressed by the same word "because."

Last, to drive the point home about how confusing English can sometimes be, the common expression "X is the reason for Y" has the same problem of double-meaning

that "because" has: it can mean X causes Y, or it can mean X is evidence for belief that Y exists/happened.

The vocabulary lesson: we must be very careful about how we use the vocabulary of cause-effect, and very cautious in how we understand what others are saying (or writing) when they use this vocabulary – especially if you are in a profession that uses the language of "responsibility," "evidence," and "reason" a lot (e.g. the legal world, the medical world, the world of criminal justice).

A) The first step is to distinguish some of our main ideas of cause in order to be clear about what we are saying when we say something causes something else. What do we mean by cause? There are several ideas and we might mean any one or any possible combination of them.

1) Going back to Aristotle in ancient Athens, there is a theory of causality in philosophy that claims each real thing has 4 causes (or each real thing is the result of 4 factors each of which can be called in some sense its "cause"):

Two are thought to be internal to a thing:
(i) a material cause – this answers the question "what is it made of or composed of?" Sometimes the material cause is matter. Example: what is the cause of that house? Answer: it is caused by this wood, and that glass, and these bricks, and that roof material, etc. Sometimes the material cause is not matter. Example: what causes a government? Answer: a government results from citizens who are leaders, administrators, and public servants, who carry out official duties. *A "material cause", then, means the parts of a thing that make it into a whole; that is, a whole is caused by its parts.*

(ii) a formal cause – this answers the question "what makes a thing to be this or that kind of thing?" Example: what is the cause of that house? Answer: the architect's design causes it to be a single-family Cape Cod style house. Or, what causes a government? Answer: a constitution causes it to be a democracy (or, say, a monarchy). Or, what causes you to be a human being? Answer: my DNA encoding certain genetic information causes me to be a human being. *A formal cause, then, is the design, pattern, or form that organizes a bunch of matter into a specific kind of thing; that is, a thing's form causes it to be the thing that it is.*

Two are thought to be external to a thing:
(iii) a final cause – this answers the question "what purpose or function causes a thing to exist?" Example: what is the cause of that house? Answer: houses exist to provide people with shelter, comfort, and a place to live. Or, what causes a government? Answer: governments are for organizing, protecting and making human life convenient. *The final cause, then, is the end or goal a thing achieves, the purpose it is for, or the function it fulfills, that makes it formed in such-and-such a way rather than in other ways; that is, a*

thing's purpose causes it to exist, or the end is the cause of the means by which it is achieved. Another example: what causes a human hand to have the design it has? Answer: a hand's form is caused by the function of grasping and holding things.

(iv) an efficient cause – this answers the question "what prior activity or event made it exist or happen, or produced it?" Example: what is the cause of that house? Answer: the builders, carpenters, roofers, etc. who built it. Or, what causes a government? Answer: usually an earlier war or revolution brings it about. *The efficient cause, then, is the prior activity, thing or event that brings a thing into existence, produces it, or makes it happen; that is, each thing or event is caused by prior conditions or events.*

These 4 causes provide the basis of defining 4 kinds of effects (or 4 meanings of "effect"). So, for example, a formal effect (e.g. a particular house's design) is the effect produced by the house's formal cause (e.g. the architect's design); a material effect (e.g. the protein molecules in that child's muscle tissue) is the effect produced by a material cause (e.g. the molecules available in the child's system from which the cells synthesized (i.e. produced) the muscle protein; and-so-forth.

This last meaning of cause – efficient cause – is an especially important and rich concept, and it has been broken down into several different ideas. They are typically presented as pairs of ideas. Here are 5 main pairs (a and b), and this only scratches the surface!

Efficient cause can mean:

1a) sufficient cause – this is the productive meaning of cause; it means a thing or situation or condition sufficient to produce the effect. For example, your biological parents produced you ("you" as a biological being); they are your sufficient cause. When we want to produce something, we'd like to know its sufficient cause so that, by causing it, we will produce the desired effect; for example, if you want to make ice and you know that cold temperature is sufficient to cause water to become ice, you can create refrigeration to make cold temperatures which cause your water to freeze.

1b) necessary cause – means a required condition, thing or situation on which the effect depends, and without which the effect cannot exist. For example, your biological grandparents did not produce you, but they caused you in the sense that without them you would not exist; they are necessary (though not sufficient) for your existence. When we want to prevent something from happening, say a certain disease, we'd like to know a necessary cause of it so that, by removing it, we prevent the undesirable effect.

2a) probable cause – means any condition that increases the probability of the effect happening. For example, smoking is the probable cause of lung cancer in the sense that continually inhaling cigarette smoke makes it more likely, not less likely, the smoker will have lung cancer. (Caution: probable cause and proximate cause (below) are often confused, be careful you understand the difference.)

2b) determining cause – means any condition that guarantees or makes it determinate, not just probable, that the effect will occur. For example, turning off a working light switch causes the light to turn off, not just probably but in a completely deterministic way.

3a) general cause – means a pattern of cause-effect of which there are many instances. For example, the claim that heat (212F) causes water to boil is general in the sense that any heat, anywhere on earth, of at least 212F applied to any pure water anywhere on earth has and will make it boil. We are claiming that there is a general cause-effect connection between all heat and all water, instances of which have occurred countless times. Many scientific laws of nature, for example the law of gravity, are expressed as general cause-effect connections between kinds or types of things or events, not particular connections between particular things.

3b) unique cause – means a one-time condition that produces a unique effect, never to be repeated. For example, a fire insurance company might try to discover the particular cause of a particular house fire, treating the fire as a unique event that never happened before and will never happen again. Or the state coroner might want to know the particular cause of a particular person's death, realizing that the person has never died before and will never die again, and that no one else has ever undergone or will undergo this unique death.

4a) proximate cause – we believe that cause-effect connections happen in chains or series. The proximate cause means that it is the cause closest to the effect in a cause-effect chain. For example, your biological parents are your proximate cause in the sense that, of all the past generations of your relatives that lead to your birth, your biological parents are the generation immediately prior to your birth. (Caution: proximate cause and probable cause are often confused, be careful you understand the difference.)

4b) remote cause – in a chain of cause-effect connections, a remote cause means any member of the chain that has at least one other member between it and the effect. For example, your biological grandparents, great grandparents, great-great grandparents, etc. are all your remote causes, all the way back to the first life forms on earth, and even all the way back to the big bang that first produced our universe.

5a) total cause – means the complete situation or entire condition to which the entire effect is due. The total cause might be one thing or event. For example, the state coroner might rule that a heart attack is completely responsible for a certain person's death, or the inspection mechanic might tell you that the only thing causing your car to fail state inspection is a burned out taillight bulb. However, the total cause might be a combination of things or events. For example, it might be that the efforts of three people caused the disabled car to be pushed into the breakdown lane.

5b) contributory cause – means a thing or situation that can't produce an effect on its own, but makes a contribution along with other things or events to yield an effect. For example, your biological mother caused you in the sense that she contributed half of your DNA, but you required the additional contribution of your biological father's DNA. Many human traits, such as musical talent, are thought to be caused by a combination of nature and nurture, each a contributory cause but neither the total cause. Smoking is not the total cause of lung cancer, but the evidence is strong that it is a contributory cause (along with, perhaps, a genetic predisposition).

Here is a list of brief formulas that captures these 10 different meanings of "efficient cause-effect". Let X represent something (a property, a thing, or the occurrence of an event or situation) and Y represent some other property, thing, event, or situation. To state that X causes Y (that is: X is the efficient cause of Y) might mean:

1a) X is the sufficient cause of Y	=	X alone always produces Y
1b) X is the necessary cause of Y	=	Y depends on X
2a) X is the probable cause of Y	=	X (as opposed to non-X) increases the probability of Y
2b) X is the deterministic cause of Y	=	X completely determines Y
3a) X is the general cause of Y	=	a pattern such that instances of the type X cause instances of the type Y
3b) X is the unique cause of Y	=	this particular X caused this particular Y
4a) X is the proximate cause of Y	=	X is the closest thing, event or situation in a causal chain leading to Y
4b) X is the remote cause of Y	=	X causes Y by causing at least one intermediate thing, event, or situation
5a) X is the total cause of Y	=	X completely causes Y
5b) X is a contributory cause of Y	=	X causes Y in combination with other things

Note that there is overlap in some of these definitions. For example, sufficient, deterministic, and total causes mean largely the same thing; they differ by way of the kind of efficient cause each is paired with, and the emphasis or interest we bring to the question: in what way does X cause Y? Also, there are other distinctions that could be made in what we mean by "efficient cause"; for example, sometimes cause-effect is stated in qualitative terms and sometimes – typically in the natural sciences – it is stated in quantitative terms as a mathematical function. But this brief survey covers most of the common meanings of "efficient cause".

The point to keep in mind is that "efficient cause" could mean different things when this term is used. So, for example, the claim that something is a cause in the sense of necessary cause should not be taken as a claim that it is a sufficient cause; likewise, the application of the idea of contributory cause to a thing is not the same as calling it a total

cause, and saying something is a probable cause should not be understood as calling it a determining cause.

B) Now we want to consider the reality to which we apply one or more of these ideas of cause-effect.

1) <u>What do we apply the ideas of formal and material causes to</u>?

a) the formal cause of a thing is the form or organization of the thing's parts
b) the material cause of a thing are the parts out of which it is composed.

These two causes are used together. We apply the ideas of formal and material cause to things that are wholes having parts. Example: a car is a whole (a form) made up of parts: tires, engine, headlights, etc. In turn, its engine is a whole (a design) made up of parts: spark plugs, gears, pistons, metal rods, etc. A spark plug is a whole (an organization) made up of parts: metal tip, wires, insulation, etc. Its metal tip is a whole (a form) made of parts: alloys, attachment ridge, etc. Another example: a human kidney is a whole (an organ with a form or design) made up of parts. Each of its parts is, in turn, a whole with its own form and its own parts,…, down to cells, to cell nucleuses,…, etc.

You see the idea. From any whole, one can go all the way down a hierarchy of whole-part levels and (perhaps?) never come to an end: an organ such as the kidney, to its molecules, atoms, sub-atomic protons, quantum particles, …; you can keep going all the way "down" to the final simple reality, if there is such a thing. As of now, and as far as we know, pure simple "rock-bottom" things do not exist – at least we haven't found them – there is always complexity and a next lower level of parts, even though technology might not be refined enough to let us work on the levels of the very, very small.

How about in the other direction? A car can be a part of a larger whole, say, a taxi fleet. A taxi fleet can be part of a business. A business can be part of an economy. An economy part of a country,…, etc.; you can keep going. Or, a kidney is part of a larger system, which is part of a larger whole,…, etc. Levels of whole-part are able to extend outward and upward in larger and larger wholes, and there seems to be no limit, no reality that is the "final whole." As far as we know, the "grand totality" does not exist. Just as there is no largest number, it seems we can always go to a next larger whole, even though technology might not be powerful enough to let us work on the levels of very, very large wholes.

So, reality seems to form a vast "vertical" system: levels of whole-part relationships, each whole is also a part of some larger whole, and each part is also a whole having its own parts.

We can represent this idea with a vertical line: the up direction represents larger and larger wholes (macro-reality), and the down direction means smaller and smaller parts (micro-reality):

macro-direction

micro-direction

Where do we break into this hierarchy? How do we single out a level of whole-parts that we might be interested in – for example, your car and its parts, or a molecule and its parts, or a galaxy and its parts? We "carve out" one small section of this hierarchy to be able to give it special attention by applying the idea of cause-effect; specifically the ideas of formal cause and material cause. Each kind of thing has its formal cause unique to that kind of thing (for example: cars or molecules or galaxies each have their "code" or "formula") and its material cause (for example: the specific parts that make up your car, or the specific atoms and sub-molecules that make up the DNA molecule).

So, formal and material causes are ideas we apply to reality in order to isolate a level of whole-part. This could be something very small such as an oxygen atom, or larger such as a human being, or larger such as the sun , or larger still such as a whole region of intergalactic space; each has its own formal cause and its own material cause. These things can be "carved out" of the whole-part hierarchy of reality using the ideas of formal and material cause-effect as our "carving tools".

2) <u>What do we apply the idea of efficient cause to</u>?

Change is the reality we apply one or more of the 10 ideas of efficient cause to. How might something change or vary? For our purposes, let's say there are 6 basic ways:

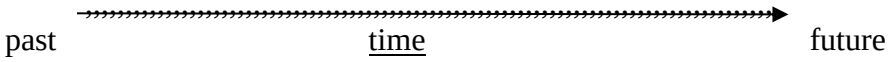
(a) it comes into existence or occurs,
(b) it goes out of existence or ceases,
(c) it increases in one or more of its properties, traits, or characteristics,
(d) it decreases in one or more of its properties, traits, or characteristics,
(e) it moves its position relative to other things around it,
(f) it stays the same (in this last case we are taking the state of stability or no change to be one of a thing's possible variations).

No doubt there are other ways a thing might change, but these 6 categories cover the main ways. Let's run through these six with two examples.
Example 1: take a noise coming from your car as you drive it. (a) The noise starts, (b) the noise stops, (c) it gets louder or it rises in pitch, (d) it gets softer or lower in pitch, (e) it first comes from the front of your car and moves so that later it comes from the rear of your car, (f) it stays exactly the same no matter how you drive your car.

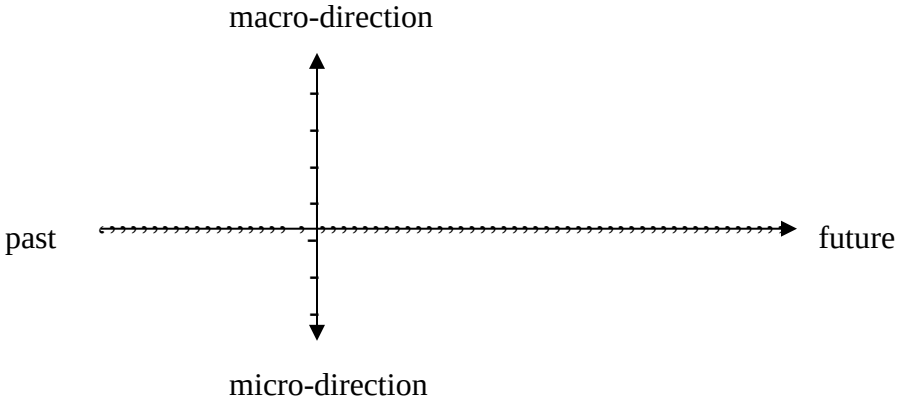
Example 2: take a rash that appears on a child's skin. (a) The rash appears. (b) The rash goes away. (c) The rash becomes itchier. (d) The rash becomes less pronounced. (e) The rash spreads to other parts of the body. (f) The rash stays the same.

Things change and situations vary in patterns, not (typically) chaotically. One pattern is sequential. Things change sequentially, in the order of time. First a thing might come into existence that didn't exist before, next it might get larger, after that it might break apart, and finally it might go out of existence. Or, something might start to exist, and next another thing might move its location, and then a third thing might stop existing.

Reality, then, forms a vast system of constant change taking place as a sequence of states or events along the order of time. Let's represent this by a horizontal line, each comma on the line signifies the state of things at that point in time, and the next comma signifying a change in things from the next earlier (next left) comma :



Before continuing, you will see where we are going by combining this horizontal representation with the above vertical representation of levels of wholes/parts:



The horizontal line of things changing sequentially can move up or down the levels of wholes/parts, and the vertical whole/part line moves from left to right in sequences of change. The ideas we have of cause-effect (formal/material and efficient) apply where these lines intersect: a level of whole-part reality is isolated by using form/matter causality, and a unit of the changing sequence of reality is isolated by using efficient

causality. Reality does not do this for us, we must divide up and isolate units of reality and using our ideas of cause-effect is one of the main ways we have to do this.

Now, back to the story of efficient causality. Changes, as you know, happen sequentially. What do we need to find in reality in order to apply any of the various ideas of efficient causality? Any one of three things will do it: (A) the continuity of something, or (B) lower level "bridges" or transmission pathways, or (C) co-variations. Let's look briefly at each.

(A) Efficient cause by continuity.
Example: suppose an event takes place, for example an explosion in a building, and later down the sequence of changes another event takes place, for example a car gets a flat tire. If there were nothing to link these two events, we couldn't apply efficient cause and say that the explosion caused the flat tire. But suppose we look at the explosion site and found that a metal container was destroyed, blown apart by the blast. And suppose we examined the flat tire and found a small piece of metal in the tire, a piece of metal that was a *part* of the *whole* metal container before the explosion. Now we would apply the idea of cause and say that the explosion caused the flat tire (even if we didn't know how the little piece of metal got from the explosion site into the tire). Why? Because something continued from the first event to the second event: namely, the small piece of metal.

Another example: suppose a certain event takes place; say, in a region of ocean fish are dying. And earlier in the sequence of changes another event took place; say, a factory dumped some of its industrial waste into the ocean. Someone now tries to link these two events by cause-effect, claiming the factory caused the fish kill. How would we know that this was a correct application of efficient causality? Well, we would drop down a micro-level or two in the whole-part hierarchy and look at the material cause of the industrial waste. Then we would drop down a micro-level or two and look at the material cause of the (dead) fish. If we found parts of the waste in the fish – that is, if there were a continuity of something – then we could apply one of the ideas of efficient cause (perhaps contributory cause or probable cause, if not total sufficient cause) and say that the factory's industrial waste caused the fish to die. But, if we found no continuity between any part of the material of the waste and any part of the material of the fish, we would not be able to apply a link by causality.

What is efficient cause by continuity? It is: (i) a part of the material cause of a thing earlier in a sequence of changes, (ii) changes its location to become, (iii) an added (not original) part of the material cause of another thing later in the sequence. The small piece of metal is no longer among the parts of the metal container, it is among the parts of the tire. The parts of the industrial waste are now among the parts of the dead fish.

The general formula is: $O_1(a,b,c,d), O_2(x,y,z) \longrightarrow O_1(b,c,d), O_2(a,x,y,z)$.

Read this as: one object, O_1, has, say, 4 parts (a,b,c,d) and another object, O_2, has, say 3 parts (x,y,z). One part of O_1, part "a", moves from O_1 to O_2. When we find this to be the case, we can say that O_1 (or O_1's changes) caused O_2 (or O_2's changes).

The metaphysical assumption in efficient cause by continuity is: the part (or parts) that moves from one thing to another is one and the same part only if it obeys the principle of continuity; that is, only by occupying every intermediary location between the two wholes. If this is not the case, then it can't be the same part; it must be another one, and then we can't apply causality.

(B) Efficient cause by pathways.
Suppose we don't have continuity of an object; instead on a micro-level of material cause we find a pathway of transmission – a series of "bridge" points of transformation – between two objects or two events. This will allow us to apply ideas of efficient causality. Here are a couple of examples.

Example: You are at the beach on a hot summer day and expose your skin to sunlight. The exposed area of skin becomes burned. On what basis can we say the sun caused your skin to burn? We won't find a tiny part of the sun among the parts of your skin, so we can't apply cause-effect by continuity. But suppose we go to the micro-level and we find a path between the sun and your skin such as this: a small unit of nuclear energy in the sun transformed into a particle of light; this light particle reached earth and entered one of your skin cells and transformed into heat energy; then this unit of heat energy in your skin transformed into electrical charge; and this electrical charge transformed into a chemical change in the skin cell. Finally, this chemical change in you skin cell happens in the same way to most of you skin cells in the area you exposed to sunlight and this change is what we call your sunburn. If the reality here was not a continuity of something, what allows us to apply causality? It is the pathway of transmission (a series of transformation points) between two events such as I've just described. Based on the existence of such a pathway, we would be able to say that these events are linked by cause-effect: the sun caused your skin to burn.

Example: We all believe that a person driving a car is causing the car to move. If we didn't, how could we blame the driver for getting into an accident if the car, say, runs a red light and hits another vehicle? However, we don't find little parts of the driver among the forces of the tires spinning, so it can't be cause by continuity. Instead, suppose that on a micro-level we find a pathway, a series of "bridges," between the driver and car movement such as this: the driver's foot exerts mechanical force that moves parts of the engine; this mechanical force transforms chemicals (fuel and oxygen) and electricity spark) into heat energy in the engine; this heat energy transforms back into mechanical motion (rotation) in the tires; and finally this rotational force in the tires transforms into forward motion of the car. The exact pathway is not the issue here; the metaphysical point to grasp is that the micro-level reality contains a pathway of transmission (rather than the continuity of something), and this pathway allows us to apply one or more of our ideas of efficient cause.

(C) Efficient cause by co-variation.

Suppose there is no continuous part and no pathway of transmission linking two objects or events, is there anything else in reality that we can use as a basis for applying our ideas of efficient cause? There is, but the best we can do in this last case is to apply the idea of probable cause, and here many mistakes can be (and are) made. Also, you should be aware that some thinkers have deep metaphysical beliefs that do not allow them to attribute cause-effect connections between things or events in the absence of both continuity and pathways. Nevertheless, most experimental scientists, especially social scientists, accept that efficient causality can be established between things and events when there is no continuous part or pathway of transmission linking them. On what basis, then, can causality be applied? The idea is that causality exists between things or events when they are linked by patterns of co-variation. How does this work?

Changes happen not only sequentially, they happen in additional systematic ways. Patterns of change form when two or more properties, things, events, or situations change systematically; that is, they co-vary.

Take the case of just two things, each changing in one or another of the basic 6 ways. Here are some examples.

Example: suppose you observe full moons (this would be a case of (a) above) and you also observe with each full moon an increase in suicide attempts in a certain population (a case of change type(c)), and when the moon isn't full (change of type (b)), suicide attempts decrease in this population (a change of type (d)).

Example: you notice that whenever a certain person joins the conversation ((a) above) your friend becomes silent ((b) above), but when this person leaves ((b) above) your friend becomes talkative again ((a) above).

Example: suppose that the more children watch violent behavior on TV (a change of type (c)) the more they engage in violent behavior in school (likewise a change of type (c)).

Example: whenever you experience a certain smell (cookies baking, perhaps) you are flooded with memories of a special childhood experience.

In such cases, there are no micro-level things that allow us to apply cause by continuity, and there are no micro-level pathways of transmission from one event to another allowing us to apply cause by pathway. But we might be able to apply probable cause-effect if the pattern of co-variation meets certain conditions. There are 3 conditions.

First of all, the co-variations must be repeated. The changes in question will have to take place enough times for us to notice whether or not there is a stable pattern of change taking place. One observation of two things changing is typically not enough to discover a pattern of co-variation (unless perhaps, using analogy, you are able to make repeated observations of very similar things changing in very similar ways). There is no exact number of times the observations of co-variation need to be made, but as a general rule, the more the better. If the things being observed can be made to co-vary whenever you

want, say by designing an experiment for that purpose, this will greatly help you to gain enough observations to discover whether or not there is a stable pattern of co-variation.

The second thing is to identify the order of priority of the sequence of changes being observed. Two things are changing in certain ways, that is, they are varying together, each in one of the six basic categories of change listed above. One will typically be earlier in the sequence; it starts to vary first and is called the independent variable (let's designate it, whatever it is, X). The other thing is later in the sequence, even if it might only be a split second; it is the one that starts to vary second and is called the dependent variable (we'll designate it Y). The idea is to create situations in which X varies in certain ways and carefully watch if Y varies, and in what ways. Then make X vary in different ways, and see if and how Y varies. You might do this in a formal way as a specifically designed experiment in which you are able to control what's going on, or you might be more informal and note how X and Y vary on their own. Either way, however, you are trying to discover a pattern of co-variation by carefully observing what happens with the dependent variable Y as the independent variable X goes through various changes. Suppose, for example, you hear a strange noise coming from your car. To discover what it is co-varying with, a mechanic in the repair shop might take your car for a drive as a formal experiment. The noise is made the dependent variable, and the mechanic will vary certain independent variables – accelerate the engine to various speeds, say, or apply the breaks with various pressures, or work the A/C fan at various speeds, or put the transmission in various gears – in systematic ways to see if and how the noise varies. But instead of a formal experiment designed to discover a sequence of co-variation (something a mechanic would do if you brought the car to a repair shop to have the problem fixed), you might informally try to notice when and how the noise varies as you normally use your car on an everyday basis. Either way, in a formal experiment or by informal observations, you are trying to discover a pattern of co-variation between a dependent and an independent variable.

The third requirement is crucial but often difficult to achieve. The independent and the dependent variables must be isolated as much as possible from "outside" or "hidden" influences and interferences. That is, you should try to control the situation enough so that other potential factors that might effect the co-variations are neutralized. This might mean keeping other things invariant as the independent and the dependent variables are allowed or made to go through their changes. Or, if this can't be done, it might mean making sure that no "outside" factors that are going through their own typical changed are disturbing the co-variations you are trying to observe. The importance of a well designed experiment, as opposed to an informal attempt to discover co-variations, becomes clear with this third requirement, for potential sources of disturbance are much more easily isolated and neutralized in an experimental setting – as hard as this is to do – than in an informal observational setting. So, for example, in observing how independent variable X and dependent variable Y are co-varying, you want to be sure they are not both effects of a hidden cause that is making them co-vary as if X's changes are causing Y's changes.

To summarize, these three conditions are: (1) the dependent and the independent variables are clearly identified; (2) we find repeated (stable) co-variation in their changes; (3) the co-variations take place in a controlled setting that eliminates, or at least minimizes, other things affecting the dependent and the independent variables. (You can appreciate that a well designed experiment comes closest to satisfying these three requirements, though even in a good experiment it is very difficult to achieve all three completely when the dependent and the independent variables are complex things, events, or situations, over which you can have only limited control, for example, human beings and their behaviors.) The concept of probable cause (often probable contributory cause) is applied – with great caution! – to things or events meeting these conditions: the independent variable is assigned "cause", and the dependent variable is assigned "effect".

Warning! There are many thinkers who argue that we have no metaphysical basis to use any of our ideas of efficient cause here. All we can honestly say, they argue, is that the two co-varying events are *correlated*. Correlation is NOT cause, they insist. The only correct use of cause, these people believe, is that based on continuity or on pathways. Co-variations are just "statistics", they claim, not metaphysics; one can find strong correlations between all kinds of event that could not possible be connected by cause-effect: for example, between sunspots and human wars, or between a person's non-material mind (mental events) and her material body (movements). What do you think of this position? Can two physical objects or events that have no physical connections whatsoever, but that co-vary in systematic ways, still be related by cause-effect?

3) What do we apply the idea of a final cause to?

Can something in the future cause an effect in the present? We normally think it can't, because a "future object" doesn't (yet) exist and so has no power in the present to affect things. Examples: a future snow fall next winter can't make roads slippery today in summer; a future flat tire can't make your car un-drivable now; a future forest fire in one of our national parks can't burn trees today. This belief that an event that will happen tomorrow or next year can't cause an effect today is part of a deep metaphysical belief that most people have: the belief that causality can't go in the opposite direction of time; that is, present events can affect the future, but present events can't affect the past and future events can't affect the present, for this would be going backward in time.

Living things, however, seem to represent an important exception to this general belief. In the case of living things, it seems that the future has the power to affect the present. Living things move and do things for a purpose; they behave and change in the present in order to achieve a future state or condition. A stone that is rolling down a hill is not trying to achieve a purpose. But why does a plant take up water, or why does a horse run? We explain the plant's and the horse's activity by referring to a future state that seems to be causing the activity. For the plant, we might say: so that it can maintain photosynthesis, or so that it can produce seeds. For the horse we might say: to get exercise, or get the

food its owner is bringing. All living things function (they move, behave, and operate) for a purpose. For example: why does a heart beat? Answer: to circulate blood. The continued (future) circulation of blood, in other words, is (in one sense!) the cause of the present beating. This kind of explanation that appeals to a future state or condition as the cause for a present activity in a living thing has a technical name: a teleological explanation (from the ancient Greek term "telos" that means end or goal or purpose). The kind of cause being appealed to in teleological explanations is, we can now see, a final cause (the word "final" also means in this context the terminus, the end point, the goal or purpose that a process or activity is heading toward or is designed to achieve).

Go back to the example of the beating heart. Notice what an interesting idea of "cause" a final cause is. Ordinarily, we would want to say the present beating of a heart causes blood to circulate in the next future instant, not the other way around! And this would be correct. But "cause" in *this* sense means "efficient cause" by pathway of transmission. However, for living things, or parts of living things such as the heart, we often feel that an explanation applying only efficient causality is incomplete, that it misses an important part of the reality of living things; a different idea of cause, the concept of final cause is needed for it addresses the purpose or goal or end (in the future) for which a present activity of a living thing is the means. Thus, to the question: what causes a heart to beat? we don't just answer: neural electrical impulses make the heart muscles contract (the efficient cause of the beating); we also answer: a heart beats so that blood continues to circulate (the final cause of the beating). In the case of an explanation only by efficient cause, we feel that something important is missed, namely the reality of a heart's function as a pump for circulating blood; what a heart is *for*, what it *does*, what it contributes to the life of a living thing, can, in a sense, be thought of as its cause.

The difference between an efficient and a final cause has been envisioned by some thinkers in this image: an efficient cause is like pushing a thing from behind, a final cause is like pulling a thing from in front. In the sense of final cause, then, a future object, state, or condition exerts a "pull" on the present (in humans by way of making plans, imagining possibilities, anticipating and expecting outcomes, etc.); it is the future cause and a present activity or condition that is directed toward reaching it is the effect. A few more examples: what causes the bird to build its nest (now)? Answer: the chicks it will give birth to (next month). Why does (= what makes) the athlete train so hard (now)? Answer: to win the sport event she will enter (next year). Final cause, then, is the cause-effect we apply to explain the vast world of living things so that we capture and don't miss an important part of their reality (and note that this itself is a teleological explanation of why we use the concept of final causality!). A vocabulary point: in the case of humans, final causes are often called our "goals," our "reasons why," our "motives," our "ambitions," or the "things we desire."

Notes:

1. This “primer” is intended as a supplement to and summary of a unit on causality in a standard undergraduate metaphysics course developed for students in a variety of professional majors, not developed for the philosophy major. Thus, many traditional and contemporary philosophical controversies are missing, such as the distinction between causal necessity vs. contingency, Hume’s theory of causality, supervenient causality, and causal directionality – topics that would be of interest to and expected in a course for philosophy majors. The focus is metaphysical, with little (in the case of efficient causality) or no systematically presented material on the epistemology of causality; e.g. explanations, conditional propositions, causal reasoning, causal fallacies, experiments designed to discover causality, isolation and control of dependent/independent variables, probability, evidence of causal connections, etc. Also, as an in-class or on-line “handout” designed to supplement class notes and assist comprehension of course material that is for-the-most-part completely unfamiliar to the target students, there are no (distracting) footnotes, references, source citations, or bibliography that would normally be required in an essay. Anyone with any background in philosophy will easily recognize the theories, philosophers, and schools-of-thought this primer draws on.