Where is Causality?

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Abstract

It is still not known how to define causality, although its importance has much been stressed in psychology, including text comprehension. The example of gravitation is presented, showing that causality has a surprisingly variable definition. The distinction between epistemological, ontological, and psychological questionings is proposed, in order to clarify earlier theoretical contributions about causality. Then the way causality was considered by works in text comprehension is briefly presented. The evolution of the field brings forth the need to define clearly causality. Recent works in the psychology of text comprehension, focusing on perception, have common grounds of study with philosophical ontology.

Keywords
Causality; philosophy; ontology; causal attribution; epistemology; text comprehension;

Introduction

Is causality an objective relation between things, or is it rather in our heads, our judgments (as far as we can know)? The aim of this paper is to stress and discuss this important question of philosophy. It has become very acute in psychology, as text comprehension has moved its focus from the question “How do we represent things?” (e.g. propositions, frames, macro- or microstructure, like in Van Dijk & Kintsch, 1983) to the question “what are the things we represent?” (e.g. places, people, time, like in Zwaan, Langston, & Graesser, 1983). While reading, causal relations is an important thing we monitor (Trabasso & Van den Broek, 1985; Van den Broek, 1988; Zwaan, 1999; Singer & Ferreira, 1995, or Radvansky, Spieler, & Zacks, 1993). While reading, causal relations is an important thing we monitor (Trabasso & Van den Broek, 1985; Van den Broek, 1988; Zwaan, 1999; Singer & Ferreira, 1983). But their definition is still very disputed (Child, 1994; Einhorn & Hogarth (1986) mentioned the relative independence of various areas dealing with the topic of causality: developmental psychology (Piaget, 1971; Lécuyer, Pêcheux, & Streri, 1994), perception and learning (Michotte, 1958, 1962), social psychology (Heider, 1958), including attribution (Hewstone, 1989), text comprehension (Trabasso, Secco, & Van den Broek, 1984). They acknowledged the fact that “the definition and meaning of cause have been debated for centuries”.

It seems timely to prolong the very complete reviews of Einhorn & Hogarth (1986) and of White (1990), because dealing with the nature of things reported by text is now a subject for the field of text comprehension, and earlier reviews presented different views on the nature of causality and the stakes it presents for the field of text comprehension. This matter is all the more acute since Barsalou (1999) popularized the idea of perceptive components of the mental representation. Causal reasoning, as mentioned by Dague, Kayser, Levy, & Nazarenko (2004) , has deep roots in our cognitive functioning, and defining causality is a very present problem.

The first section presents the example of Newton’s gravitation: the history of this theory’s reception shows that what makes causal relations (whatever it is) is a very changing thing, and this may help convincing us that causality is far from being captured by psychology as a stable thing whose properties can be defined in general (so for psychology in particular). Then three types of causal relation are proposed, clarifying the nature of studies on causation. Classifying this way may help to “tidy up” this huge problem: it can be distinguished between epistemological, ontological, and psychological causalities, although problems are almost always , by authors who claim dealing with causality in general. This section concludes that the main question about causation, for both philosophy and psychology, is whether causal relations are (for what we can know) real (objective), or mental (the result of a judgement). We then move on to the way text comprehension theories dealt with causality. We conclude by showing why it is an issue for psychology to deal with the question of what causality is.

1. Evolution of the idea of causality

Consider an elementary example. Let me drop (stop holding) a stone in the air, without moving. It will surely fall to the ground. What’s the cause of this fall? It’s likely that you’ll agree with me that gravitation force caused the stone to fall. The stone fell because of gravitation, when I stopped holding it. This idea seems quite common, but it has not always been. Not only because the theory of gravitation was not always known, but because gravitation force did not always seem the cause of anything to intuition. Indeed, Newton himself, in his Principia Mathematica (in 1687), asserted that his theory said in no case what the cause of movements was. He writes: “I have not been able to discover the cause of those properties of gravity from the phenomena, and I frame no hypothesis”. Rather than understanding his discoveries as causal explanations, he takes them as descriptions of phenomena, which do not unveil their “occult” causes: “Truth appearing to us by Phænomena, though their manifest qualities, and their causes only are occult” (Henry, 1988). Newton replies: “For these [the active principles he used] are manifest qualities, and their causes only are occult” (Henry, 1988). The operational value of his theory was admitted quite fast, but in a Cartesian context, in which only movements and contacts between material bodies were admitted as causal explanations, the principle of gravity (or that of magnetic field) didn’t seem intelligible to contemporary physicists (including Newton himself). Mechanics was just liberated from the scholastic occult qualities, since Galileo and Descartes; and any idea of a distant action seemed an obscurantist regression. According to Liebnitz, “Gravity must be a occult quality, or the effect of a miracle” (Henry, 1988). Newton replies : “For these [the active principles he used] are manifest qualities, and their causes only are occult” (Henry, 1988). The very idea of a distant action of a body on an other one, without intermediary contact forces, was unacceptable (for the following generation also : on Euler, see Wilson, 1992). Modern science progressively included in causal comprehension the “mathematical comprehension” of phenomena (Auroux & Weil, 1992). In other words, the scientific commonsense, followed by the vulgar one, finally accepted as causal or explicative a mathematical description. Earlier in the history of science, mathematics were limited to describing phenomena, addressing the question “how?” rather than the question “why?”.

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This example illustrates that our idea of causes changed a lot in recent history. What we take as causal today depends not only on the state of science, but also on other factors, which vary with the socio-historic context. To this difficulty of a varying definition, one can add the magnitude of the field of phenomena we want to explain causally, and the variety of things for which the question “why?” can be asked.

2. Three types of causality

This example was taken from the field of scientific truth. The issue of defining causal relations can be clarified by considering the field in which various authors in the past considered the question. This issue may have different answers, whether you’re trying to define a correct way to determine causal relations in science, or if you’re wondering what a causal relation is in reality, or if you’re examining the idea of causality humans have (to make mental processes efficient). The three fields (epistemology, ontology, and psychology) may lead to the same answer, but not necessarily. Although science in general can go on whatever causal relations really are (because it’s been more than a century that J.S. Mill’s criteria have proven efficient), it is still an issue for ontology and psychology to localize causal relations, whether in “things” or in our minds.

The three types of causality we suggest differ a lot from the four kinds proposed by Aristotle: material, final, immediate, and formal. These four kinds fully cover the field of the loci of answers to the question “why?”: Among the four, only one kind has left the field of causal explanation; the material cause. What the thing to explain is made of doesn’t belong to a causal explanation anymore. Nowadays, the final cause, which tends to explain things by their result, applies more to the daily explanations of human behavior, to intentionality. The efficient cause is indisputably the closest idea to our contemporary idea what makes a cause, as shows the preceding example. Scientific explanation has also included formal cause, since it often associates mathematically described features of entities with their nature: for example, the movement of a proton is described by such and such equation, and the movement of an electron is described by such other equation.

By contrast, the suggested distinction addresses more the relation between the world and our mental representation. Three types of causality can be distinguished: epistemological, ontological, and psychological. Such a distinction would make clearer the issue of causality, by clarifying the topic tackled by each view.

Epistemology is the field in which it was originally tried to determine how to back a causal explanation. If one sums up Hume’s contribution, his theory set a challenge to modern science, by showing that a causal relation could not be proved. Scientific truth depends on causal relations based on cooccurrence, a synthesis of experience, joined with the unproved belief that the world will remain working the same way. In other words, the findings of science are not rationally proved. Such a challenge woke up Kant from his “dogmatic sleep” (Kant, 1783/1986). Kant moved the referential, from “the world” to our mind, asserting that the causal relation is not inferred, but an a priori structure of our understanding, working like a filter of our apprehension of phenomena. This solution was summed up by Emmet (1984): “Hume declared all consequence to be mere sequence; Kant, on the other hand, affirmed that there is no other [irreversible] sequence but consequence”. Although Kant’s idealism was an elegant philosophical solution to Hume’s challenge, it did not provide firm criteria for science. J.S. Mill did, with his System of Logic (1848), defining methods on which scientific inference could rely. The focus on epistemological issues, in the study of causality, has remained in psychology, and in the field of causal attribution, it is examined to which extent people behave as “lay scientists” and use statistical information to determine causes (Hewstone, 1989), as does science.

One can also wonder what the causal relation is ontologically, in addition to the concern for making correct inferences. In other words, scientific knowledge must establish efficient criteria for determining causal relations, but such epistemological criteria are distinct from an interrogation on the nature of the causal relation. One could think that since ontology is a matter for philosophers, Hume’s contribution, which is a landmark of the reflection on causality, deals with this matter. In fact, Hume placed the causal relation in our minds rather than in the objects themselves, thus evacuating the problem of the ontological nature of causality towards epistemology and psychology. The ontological question still holds a very important place, as show Donald Davidson’s (1975/1993; 1967) contributions, who based the identity of body and mind on his conception of what causality is. Davidson asserted that real things and their linguistic description must not be confused. Particular causal interactions between mental events and material events may be true, but only in their material descriptions. An event is mental in the sense that we have elaborated a description of this event as mental (but there also exists a material description of this event). For him, causality implies the existence of a causal law (that’s how he defines a nomological regularity). There is a causal law relating events under their material descriptions, but not necessarily under other descriptions (e.g. as mental events). He states that things can be causally related through causal laws (he’s a determinist), but not under all descriptions (and founds on this idea the concept of supervenience).

In addition to the recent developments of analytical philosophy on the nature of causality, this nature is also a matter for psychology since it is interested in perceptive aspects of mental representation. The perceptivist approach introduced by Barsalou (1999) moved the focus of research on text comprehension to its perceptive components (Zwaan, 1999). Of course, exploring the perception of anything (and causal relations in particular) raises the need to determine which elements of reality are perceived. White (1999) also defends a view of perceptible causality. Perception is the mainspring between ontology and psychology.

The psychological approach of causality is more concerned by the idea we have of causal relations, and by their importance in some psychological processes. In exploring our notion of causality, psychology picked of course ideas in both fields of epistemology and ontology. As White (1990) puts it, instead of making hypotheses on what people think causality is, the grounds on which causal relations they establish can be explored. It can be tried to establish whether people determine causal relations “as if” they were statisticians, or “as if” they had a theory of some kind to determine causality. Trabasso & Bartolone (2002) challenged the hypothesis of Kahneman & Tversky (1982), who proposed that counterfactual reasoning was used for determining causes.

The causal relation, for the ontological and psychological types, could be described by the question “Where is causality?”. The answers of each field to this question are interrelated. For example, the philosopher Mackie (1974) is much cited by the psychologists Trabasso and Van den Broek. Mackie thinks that causal relations are objective facts; he also wondered where our idea of a causal relation comes from, and proposed that counterfactual reasoning was the root of causal judgements. Kistler (2004) also defends a view according to which causal relations are objective facts, characterized by the transmission of something (a physical magnitude of some kind, like energy). We can note that the philosopher Mackie (1974), to back his claim that causal relations could be perceived, cited psychologist
Michotte (1953) who claimed that his experiments proved the perception of causality. But from a closer consideration, maybe Michotte’s experiments can be subsumed under works on mental semantics: he considered that causality was perceived whenever his subjects described what they saw using a verb (e.g. “launching”) that Michotte himself judged expressing a causal relation. That’s what he called “perception of causality”. It can be argued that these experiments do not concern the perception of causality, but the relation between perception of phenomena and their verbal description. The role of perception, in more recent theories, like that of Barsalou (1999) is nowadays considered under a different perspective, that of the possible analogy between mental representations and “real” things. For dimensions like time or space, their description is rather straightforward, and there are universally accepted tools for describing them (meters or seconds). But causal relations are not so straightforward. Both views remain, that causal relations are an objective reality (e.g. Trabasso, Mackie) and that causal relations are the result of a synthetic judgment, in the spectator’s head (White, 1990 refers to this view as a commonplace; Russell, 1989/1912 wrote it was the general opinion for “all people of good faith”).

Ontology and psychology may have different answers to the question “Where is causality?”, but psychology needs to answer it and determine which cues to a causal relation we currently use.

3. Causality and text comprehension theories

Monitoring and representation of causal relations was shown to be important in the psychology of text comprehension. Warren, Nicholas, & Trabasso (1979) described the representation of a text as a set of facts and relations. The relations between facts are causal, or temporal by default. Black & Bower (1980), following Shank (1975), formulated text comprehension as problem solving: the problem is to relate the first and the last fact with a causal chain, called ‘critical path’. They showed that events belonging to this path were remembered better than events belonging to a “dead branch” of the net. Omanson (1982) used this representation to prove that the more central an event in this net, the more important it is judged, and the better it is remembered. Trabasso and his colleagues extended this “local” view of coherence to more distant relations of causality. Trabasso an Van den Broek (1985) used the RTN (Recursive Transition Network) for representing text informations in nets: nodes are clauses, and relations the causal relations suggested by Warren, Nicholas, & Trabasso 1979.

Trabasso and Van den Broek used the criterion of counterfactuality proposed by Mackie (1974). This criterion operationalized that of necessity in the circumstances. The representation of text in a such nets was shown to predict important features of text elements: causal connectivity predicts recall (Fletcher & Bloom, 1988 ; Trabasso & Van den Broek, 1985), the speed of recuperation (O’Brien & Myers, 1987), importance judgements (Trabasso & Sperry, 1985 ; Trabasso & Van den Broek,1985 ; Van den Broek, 1988), the probability of inclusion in summaries (Van den Broek & Trabasso, 1986), and the strategy for keeping information in the short term memory (Bloom, Fletcher, Van den Broek, Reitz & Shapiro,1990).

Trabasso, Van den Broek & Suh (1989) also used the RTN to differentiate four types of causal relations (physical, motivational, psychological, and preconditions). Tapiero, Van den Broek & Quintana (2000) confirmed the following hierarchy of judged strength (from the strongest to the weakest): psychological causality, motivation, precondition, physical causality.

Van den Broek (1990) presented a complete view of the role of causality in text comprehension: criteria for determining the causal relation (temporal priority and operativity), and logical criteria for determining causal force (necessity and sufficiency). However, his criteria don’t explicitate what makes causal relations. He provides no rules for the estimation of necessity and sufficiency. The representation in RTN’s impacts both individual events, and the relations between events. Van den Broek & Lorch (1993) showed that events directly connected in the net led to a better mutual recall (indexed recall); this result was replicated by Quintana 2000.

Keenan, Baillet & Brown (1984) showed that a sentence was read faster if the event it related was more likely (by elaborating four classes of causal relatedness of cause-consequence couples). Myers, Shinjo & Duffy (1987), and Duffy, Shinjo & Myers (1990) replicated this experiment, and found that cause-consequence couples of intermediary likeliness were best memorized. This suggests that memory is linked to the inference process linking causally events of the text: minimal effort for very likely or very unlikely cause-consequence couples, hence less memorization. Many works focused on causal inferences. Singer and his collaborators elaborated the validation model. According to this view, causal connections are made between events thanks to the elaboration of the knowledge missing for a syllogistic reasoning (Singer & Ferreira, 1983; Singer, Revlin & Halldorson, 1990 ; Singer, Halldorson, Lear & Andrusiak, 1992 ; Singer, 1993; Singer & Halldorson, 1996). This knowledge allows the validation of a causal connection of the causal connection. There is mutual priming between the general knowledge and the specific situation (Halldorson & Singer, 2002).

The role of causality in the temporal course of reading was also studied by Noordman & Vonk (1992), and Noordman, Vonk & Kempf (1992). They confirmed that reading was faster in causal condition (see also: Haberlandt & Bingham, 1978; Zwaan, Magliano & Graesser, 1995). They mentioned a research led by Sanders & Noordman showing that causal relations are processed faster than additive relations. They distinguish between integration processes and inference processes. Integration refers to the fact that events are causally connected (vs. linking information). They consider the connection causal by default (Van den Broek, 1990b). Other types of relations between events, like mere temporal succession, are more costly because they are considered only after it has been tried to connect events causally without success. This view is coherent with that of Zacks & Tversky (2001), who indicate that events are preferentially organized through causal organization in mental representation, before temporal and spatial data.

Conclusion

Recent developments in research on text comprehension examined different aspects or dimensions: space, time, reference, goals, causality. Partial comparisons between dimensions were examined: space and reference (Radvansky & Zacks, 1991 ; Radvansky, Spiller & Zacks, 1993), time and reference (Radvansky, Zwaan, Federico & Franklin, 1998), space and time (Rinck & Bower, 2000), space, time and rederence (Scott Rich & Taylor, 2000), space and causality (Friedman & Miyake, 2000). The multiple-indexing model proposed by Zwaan and his colleagues (Zwaan, 1999 ; Blanc & Tapiero, 2001) showed that the five aspects were important, by considering them together, in categorization (Zwaan, Langston & Graesser, 1995) reading times, and memory (Zwaan, Radvansky, Hilliard & Curiel, 1998 for reading times ; Zwaan, Magliano, & Graesser, 1995 for reading times and memory). Causality, among these dimensions, is particular : space, time, and reference have “natural” and commonly used descriptions in objective reality (meters, seconds, objects).
Goals, which can be subsumed under causality, is a dimension close to reference: the relation of goal is binary (either a thing is or is not a goal for an event). Causality describes only relations, whereas space, time, and reference, allow also one-dimensional situation of events. As text comprehension theories are more and more concerned with the contents of representations, they have to determine more precisely what causal relations are (as in ontology), and be able to determine which method is used psychologically to identify them (as in attribution). The methods elaborated for epistemology don’t apply best to psychological processes. Data linked to probabilities are useless, and completely overlooked by the problematic of perception. The current evolution of the field of text comprehension emphasizes the connection between psychology and philosophy.

References


