

Logical Phenomena In Causality

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1. Introductory Note

This paper deals with causativity (or as called in logic "causality"). This phenomenon has been widely discussed by logicians and philosophers in a way different from that of linguistics .

In this paper the following issues will be examined :

1. The close relation between semantics (which is an important aspect in linguistics) and truth values in logic and philosophy .
2. Factive verbs (which are those verbs that presuppose the truth of their complement like **know** and **realize**) and whether or not they are treated similarly in both linguistics and logic .
3. Whether or not some verbs which are considered causatives in linguistics are similarly treated in logic .
4. Whether or not the following issues in linguistics correspond to those in logic and philosophy (like , for example, **agent's role** , **duration** , **causing action** , **event** , etc.) though they have different names in each field , for example "**agents**" (in linguistics) are referred to in logic as "**causes**" .

The issues which will be discussed in this paper are those of direct relevance to this paper and correspond to linguistics .

Charlton's theory (1983) , Good's (1961 , 1980) and others' will be introduced briefly here , because they are , in a way , parallel to the linguistic analysis and are also related to other issues in linguistics which correspond to Von Wright's (1968 , 1971 & 1974) calculus , truth values , and the probability theory .

2. Logical Equivalence and Semantic Equivalence

Logical equivalence and semantic equivalence are names for the same concept .

In term of linguistics when sentences are synonymous it means that they are semantically equivalent to each other . In terms of logic and philosophy they are considered to be logically equivalent to each other , which means that if one of them is true the other must be true and vice versa . If two sentences are not semantically equivalent , it means that they are not synonymous and thus they are also logically not equivalent to each other , that is due to the close relation between semantics and truth values . Consider the following sentences :

1. Ali asked Helen to visit John .
2. Ali asked John to be visited by Helen .

In these two sentences there is neither semantic equivalence nor logical equivalence because in 1 Ali asked Helen and not John and in 2 he asked John and not Helen . In 1 it is true that Ali asked Helen to visit John , and in 2 it is not true that Ali asked Helen to visit John though it is true that Ali asked John to be visited by Helen .

The following sentences from Morgan (1973) have logical equivalence , and neither of them can be true without the other :

- 3a. John has never married .
- b. John is a bachelor .

The difference is that 3a can occur with the context (because he cannot stand the ceremony) while 3b cannot occur with this construction unless it is amended as in 3e:

- c. John has never married because he can't stand the ceremony .
- d. *John is a bachelor because he cannot stand the ceremony .
- e. John is a bachelor because he cannot stand a marriage ceremony .
- f. John is a bachelor because he does not like marriage commitment .

3d above has been tested with 5 native speakers and was accepted by only one of them .

The unacceptability of 3d may be attributed to the fact that the nounphrase (henceforth NP) the ceremony needs a modifier and it also exhibits an anaphoric use of a definite article for which there is no logical operator in the sentence . An operator is a function which (from a specific syntactic position) modifies a set of properties . It can also be considered as a function which does not require an argument in contrast to a predicate which requires an argument (see Von Wright , 1963) . The negation of sentence 3d causes redundancy in the semantics when used with the NP the ceremony whose semantic information asserts contradiction in the construction . The NP ceremony is logically more acceptable with verbs rather than

with adjectival clauses . Sentence 3c is acceptable as the NP occurs in a verbal predicate and not adjectival clause . The lexical restrictions of the NP have some effect on the semantic structure of the sentence . Another reason may be attributed to the phrase itself where it does not justify the answer why ; especially when only the subordinate clause is negated because semantic equivalence is not logical equivalence . Consider the examples below which are synonymous :

4. The two children were each scratching the other's back .
5. The two children were scratching each other's back .

But the following examples have neither logical equivalence nor semantic equivalence because they are not synonymous .

6. The five kids were each scratching the others' backs .
7. The five kids were scratching the backs of each other .

The lack of logical equivalence and synonymy between sentences 6 and 7 is due to the position of the term each other which indicates uncertainty about the agent and recipient of the action . The syntactic position of each other in 7 imposes some restrictions on the sentence which does not make it clear whether or not each of the five kids has taken part in the action and received the action as well ; thus they are not synonymous

The semantic structure of the phrase each ... the other is different from that of each other and this difference has an effect on the semantic structure . One should not think that each ... the other is derived from each other or vice versa because each of them seems to have a different lexical entry .

In some cases the unacceptability of sentences like 8 and 9 below which are from Morgan (1973 , 26) , is attributed , in logic , to the logical imagination of the hearer:

8. * The orphan is living with his parents .
9. * They killed him but he did not die .

One cannot imagine any state of affairs in real life where these two sentences can be true . The logical contradiction shown by these sentences is responsible for the unacceptability in the logical structure as well as the semantic structure in linguistics . The logical structure here for a proposition P entails a structure of the form :

P (means either P exists) or
 ~~~~~ P      ( not , as ~~~~~ stands for negation )

This structure in logic represents truth values which are true or false . If two sentences are synonymous they must have the same truth value . In a causal situation , when the causal factor which ( corresponds to the action in linguistics ) influences the act chosen , it must influence the agent's beliefs and desires in such a way that an outcome is produced from that action which also exhibits the truth or falsity of the situation and that is how semantics and truth values are close and play a role in causativity .

In logic , the agent's role seems to be an important element in a causative situation . This observation may emphasize the fact that causativity can be best represented through semantics and can be clearly expressed through semantics more than any other linguistic aspect , for more details (see Morgan , 1973) who adopts a point of view which supports mine here .

### 3. Logic and Factive Verbs in Relation to Causation

Factive verbs are those verbs that imply a true belief like know and realize . It seems logicians are also concerned with factive verbs and have related them to causativity considering factivity as a part of causativity on the basis that the agent's beliefs are influenced by the causal factor in such a way which shows the factive presupposition of the verb's complement and that's how factivity is part of causativity. In other words the causal factor may exhibit the truth or falsity of a presupposition which confirms or denies the factivity of a verb in a particular construction . On such bases there is a relation between linguistics and logic concerning causativity .

Factivity , as a semantic phenomenon is one of the features of the verb **know** but at the same time it is also a consequence of the semantic notion of **know** . It can also be considered one of the selectional features of the verb **know** as it occurs only with true complements . The verbs **believe** and **think** do not hold such characteristics .

If one compares the verbs **think** and **believe** with **know** , one may notice that the first two are unlike **know** as they do not presuppose the truth of their complement .

Yamanashi (1972 , 392) has claimed that the verb **teach** implies the idea of <CAUSE TO KNOW> , In linguistic situations one cannot overlook the semantic restrictions that a verb imposes on its sentence . However teaching someone does not assert that he/she knows what he/she has been taught as it has been suggested by Yamanashi (1972) . It is not always true that Z knows what X taught Z because if Z knows Y there is no need for X to teach Z . It is not always true that Z learns Y . If Z learns Y then one can say Z knows Y . The case could or could not be true that X taught Z Y but Z does not learn Y and in the second case it cannot be said that Z knows Y . One can claim here that know is derived from a construction like



<CAUSE TO LEARN> and not from <CAUSE TO KNOW> . It may also be derived from <TELL> or <INFORM> .

The relation between these verbs is similar to that of kill and <CAUSE TO DIE> or <COME ABOUT ...> . The implicational relation between kill , cause and come about is hierarchical (1) This hierarchy is captured in the semantic representation which implies propositions of different verbs regardless of whether they are predicates , constraints or single verbs .

Karttunen (1970 , 328-39) and (1971 , 340-58) has examined some implicational relations between a sentential predicate and its implied complement sentence where the sentential predicate has been classified as a "factive verb" . This classification was based on surface sentential verbs and has also been sub-classified into several other sub-types . It includes verbs like realize , pretend , fail , happen , force , cause , make , have , persuade , prevent , keep , hide , hesitate , find out , learn and discover where karttunen (1971) has claimed that the last four verbs lose their factive property when they occur in some modal context . Consider his examples below :

10. It is possible that John will discover that this wife was unfaithful .
11. His wife was unfaithful .

In these two sentences the speaker asserts the truth value of 11 and asserts 10 without presupposing 11 to be the case . Sentence 10 loses its factivity when the speaker or hearer asserts that John may discover that his wife was unfaithful , i. e. it is not always true that he may discover because the sentence is not in the past . If the context has the past tense the sentence will not lose its factivity . This is because factivity is part of causativity (through the relation of semantic and truth values) and causative constructions are always true when their action is carried out in the past because it asserts that the result is achieved .

An interesting argument has been raised by Yamanashi (1972 , 388401) about implicational relations in "factive verbs" where the verb forget has been offered as an example to fit the following logical formula :

$$\begin{array}{ll} \text{A} & \text{FORGET (X,S)} \supset S^{(2)} \\ \text{B} & \text{~~~~~ FORGET (X,S)} \supset S \end{array}$$

Yamanashi has demonstrated that the verb forget is derived from the predicate <COME ABOUT THAT X DOES NOT KNOW ...> or <CEASE TO KNOW>(3)

Consider the following examples and their DS representations from Yamanashi (1972) :

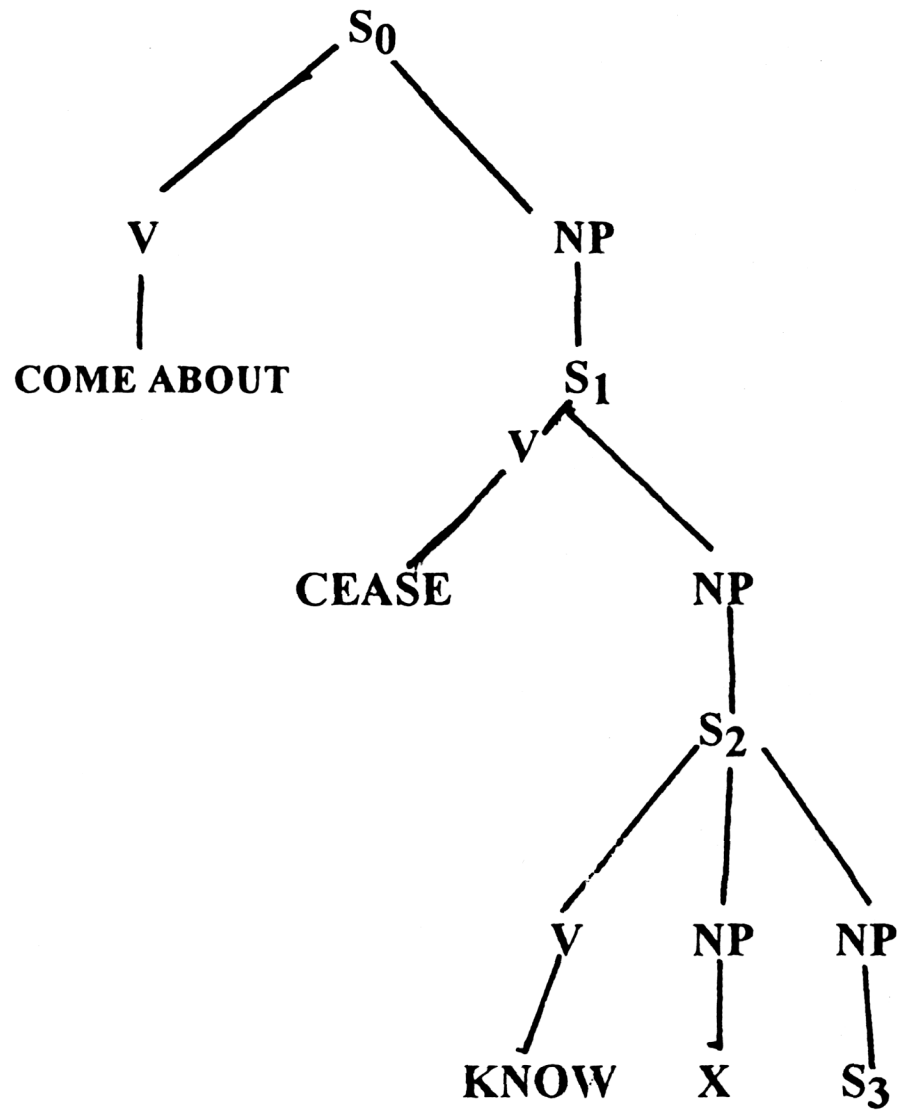
12. John has forgotten that he was a singer .

13. It has come about that John does not know that he was a singer .

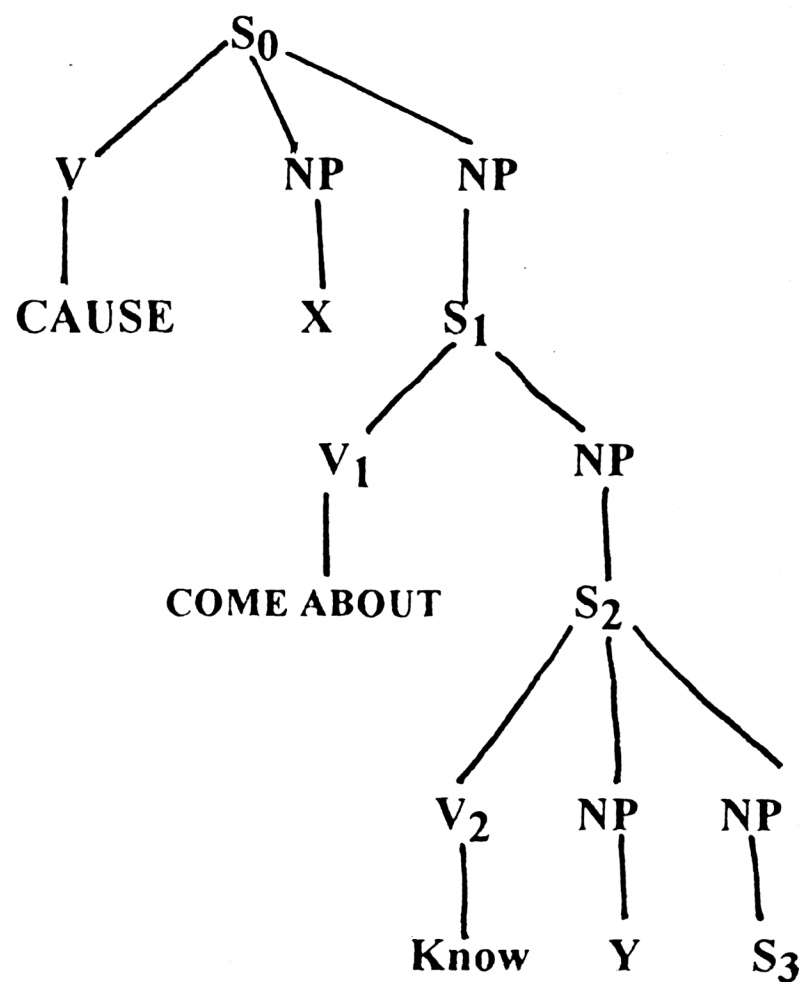
14. It has ceased to be the case that John Knows that he was singer .

15. John does not know he was a singer .

### D.1

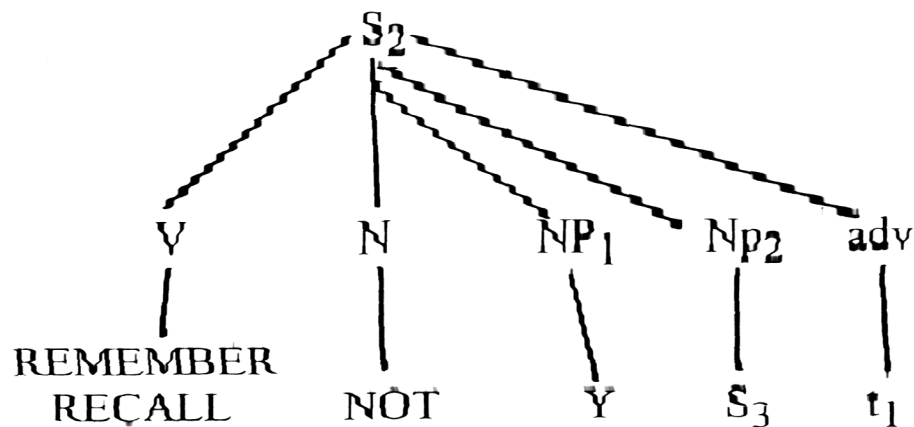


### D.2



One may apply the following amendment to SR of Yamanashi's configuration (above) as follows :

### D.3



One cannot derive the verb **forget** from the predicate <CEASE TO KNOW> because , semantically , the verb **forget** does not indicate that one stops knowing something . The verb **forget** conveys a notion like (one does not know at a particular moment) . One also can claim that it can be derived from a predicate <NOT TO REMEMBER IN T1><sup>(4)</sup> or <CEASE TO REMEMBER IN T1> or <CEASE TO RECALL MEMORY IN T1> . The predicate <CEASE TO KNOW> indicates losing one's memory for ever or losing previous knowledge/information about something . One has to be aware of the semantic restrictions of items , predicates , constraints and verbs , because overlooking these restrictions leads one to offer loose suggestions which may be confusing and not accurate , which not only do not solve the problem , but may complicate it .

#### 4. Causal Relations and Duration in Logic and Philosophy

Von Wright (1963 and 1968) has noticed that an action is understood to have taken place at a certain time if a state is replaced by another at that time (e.g. the action of closing a door) . The first state is that of (the door's being open) which is replaced by the second (the door's being closed) . The relation between a state and a change of state seems to be similar to the relation between an action and event in a causative situation . The difference between these relations in logic and linguistics is that in logic the two states have some special form where usually one of them is the negation of the other . The first change of state is replaced by the second q.

$p = \neg q$  or vice versa , i. e.  $\neg p = q$ .

On this basis , Von Wright has derived a formal calculus which he called "the calculus of change of state" .<sup>(5)</sup> The calculus consists of classical propositional logic

with an operator called "And next" which is represented by the capital letter "T". The calculus allows the reduction of all formulas to one out of the following four basic types :-

- **-pTp** "the state where **p** comes about"
- pT-p** "the state where **p** is destroyed or comes to an end"
- pTp** "the state where **p** remains or continues to obtain"
- pT-p** "the state where **-p** remains or the state **p** fails to come about"

The "change of state" in this case is similar to an event. It may have a notion of causation since its result is implied, though not explicitly expressed but **Von Wright** did not draw a difference between an event and a change of state and considered both of them as "events". An event is a result of an action whereas a change of state is an outcome of a state and on bases of **Von Wright's** calculus it is equal to an event, e.g. (the rolling of a stone) is a change of state (see next section). A change of state may, in some linguistic situations, implicitly, indicate within the action an event or part of the event in verbs like legalize or defrost.

## 5. Causal Elements and Causal changes

Logicians and philosophers like **Von Wright** (1963), **Shopen** (1972), **Salmon** (1980), etc. have dealt with causation as a change brought about by an agent. **Charlton** (1983, 143) has explained this type of change in various terms "**causal agents, causal actions and causal conditions**". "**Causal agents**" are material objects like the sun, clouds, trees and human beings. Such agents, when used in a causative expression, exert power or force to produce a change. "**Causal actions**" are events by which the agent brings about a change. The "**causal condition**" (which is responsible for the change) is itself a state of affairs without which the action would not have been brought about or brought the change about. Actions like sewing, running, writing, etc. are examples of causal actions which are called "**exercises of skills**" by **Charlton**.

Not all changes referred to by **Charlton** are brought about by causative verbs, as some of the actions are expressed by verbs that do not show causation because they are only transitive verbs. Not all the actions referred to by **Charlton** are caused by changes only, they could be caused by some other factors which are either linguistic or non-linguistic or both.

If one examines a causative situation in a certain state of affairs one may assume that **X** causes **Y** if and only if **Y** is affected by the action of **X**, i.e. if **Y** is not affected by **X**, then, **X** does not receive the causing action (which leads to the result). If neither **X**

nor **Y** exists (or any other causer or recipient of actions) the situation cannot be called causative . Since **X** also causes **Y** (which cannot cause **X**) one can claim here that causation runs forwards and not backwards , i. e. **Y** always follows and never precedes **X** .

Logic is involved in the truth or falsity of sentences in natural languages . Logicians usually set two values for a sentence which they refer to as a proposition . These values are either true or false see Stebbing (1930), Suppes (1957) , Schipper & Schuh (1959) , and Copie (1973) . Lakoff (1972 , 255) has set a third value which is neither true nor false and called it "nonsense" value . It always makes sense to ask whether **P** implies **Q** and if so how far (i. e. to what extent) such implication is based only on true or false values and not on "nonsense" values .

Semanticists like Lakoff were influenced by truth values , perhaps because there is a close relation between truth values and semantics when no way other than truth values can help in the analysis of a certain phenomenon .

When an event is involved in a cause-effect relation , it obviously yields to a causal process which accompanies each causal result . For example , assume **A** had an intention of killing **B** by a bullet and **C** knew about that intention and tried to save **B** by emptying the pistol . Instead of saving **B** , **C** by mistake killed **B** . In this case **A** is not always a genuine cause of **B**'s death . **C** or **D** may intervene (depending on each causal situation) . One may recognise two types of causes : interactive (see Lakoff , 1972) (like **A**'s action if it was carried out) and conjunction (like **C**'s action which produces a result unintentionally) :

A intends to kill B

C's actions carries out A's intention

C kills B

Good (1980 , 301-3) has revised his ideas which he put forward in (1961) where he (p. 309) claimed that **E** and **F**<sup>(6)</sup> denote small events in space time . **E** is preceded by **F** in occurrence . In (1980 , 301-3) Good claimed that **Q(E:F)** is equal to the "weight of evidence" against **F** when **E** does not occur .

## 6. The Probability Theory and Causation in Relation to Duration and Action's Direction

The probability theory asserts that causativity or causality is transitive , meaning that it is transferable from one period of time to another forward and not backward . On this basis a causal relation between an action and event in a given situation is associated with time direction which is usually pointing forward and not backward .

Such relation indicates that an action always precedes the event . The direction is usually related to duration which is transmitted from cause into effect .

The probability theory asserts that the cause raises the probability of the effect . In other words the cause increases the chances of achieving the result through different durations by moving from one duration to another , forward and not backward . This observation supports the claim made earlier in this paper that causation is a forwards process .

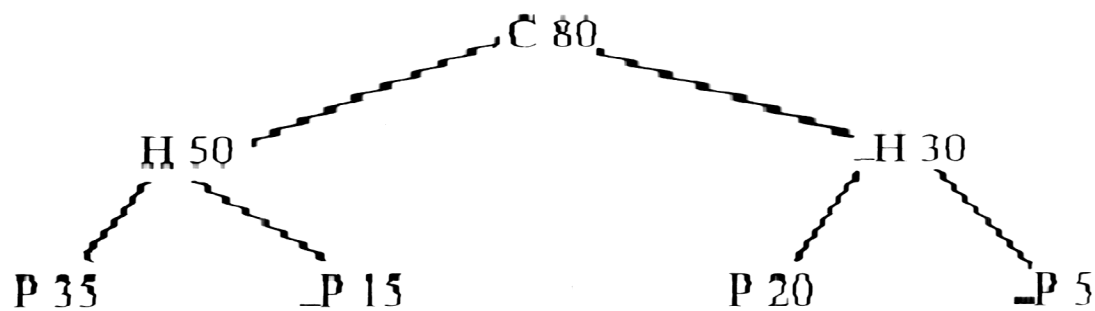
**Skyrms** (1980 , 137-9) has claimed that a cause must raise the probability in , at least , one maximal configuration of causally relevant background factors and must not lower it in any of the others . It is not easy to explain how this theory works . Perhaps the easiest way is through the following example :

One may assume according to the probability theory that coffee increases the chances of heart attack/cancer . The probability theory does not generalize that drinking coffee/smoking causes cancer but it proposes that it helps in developing it or in other words there are some individuals to whom smoking or coffee drinking may cause cancer/heart attack . The probability theory asserts that it may happen , that some smokers or coffee drinkers do not have heart attack/cancer , though it does not provide evidence for this possibility > If it does , it would have involved contradiction which makes it inadequate , because it offers many possibilities for the result of an action to be achieved and for the action to operate .

Consider the following example which may not be of interest to linguists who are not interested in logic , but it has been felt that it is necessary to introduce it here to explain the causal relation and durations in terms of logic and the application of the probability theory : If one assumes that at a certain time  $t_1$  people drink coffee or consume cigarettes **C** . After a period of time  $t_2$  they either have started to develop cancer **H** or have not  $\neg H$  , and at a later time  $t_3$  they either have cancer **P** or do not  $\neg P$  . If this comparison is made between 80 coffee drinkers/smokers and 80 non-coffee drinkers/non-smokers at  $t_1$  and their respective properties of cancer are traced through  $t_2$  and as illustrated by the following diagram one may have the results below :

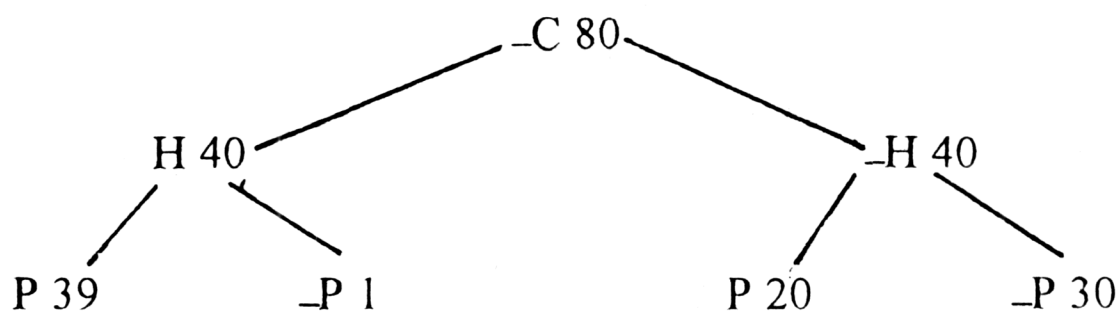


**D. 4A: The probability in causal relation between coffee drinkers/smokers and cancer development**



The same example may be applied in the same way to a group of non-coffee drinkers/non-smokers as illustrated by the following diagram :

**D 4B: The probability in causal relation between non-coffee drinkers/non-smokers and cancer development**



In the diagrams above (4A and B) , either **C** causes **H** and , in this case , **P** and **C** are the only factors that need to be identified in deciding whether **H** causes **P** or not , and whether or not there are other unknown factors that contribute towards the result .

If the first possibility is true , it can only cause cancer by raising the effect of drinking coffee/smoking forward and not backward which indicates that causation is associated with duration (which is an important factor in causation) . This possibility is more likely to occur within the class of non-coffee drinkers/smokers . The possibility of getting cancer depends not only on whether one had it at  $t_1$  or  $t_2$  but also on whether one drinks coffee or smokes or not at  $t_1$  which implies that causality (if there is a causal chain in such situations) is transitive which means that the effect transfers from  $t_1$  to  $t_2$  or  $t_3$  ; i. e it has the property of transition which means that the influence of the action moves forwards towards the event .

In the light of the discussion of this paper and for its purposes , causativity or causality can be defined here as a relation between an action and an event or a change of state . This action can be either a deliberate or an incidental act carried out

by an agent under some circumstances which help in achieving the result caused by the action (see **Bialock** , 1964 and 1971 , **Copi** , 1973 , **Creswell** , 1973 and **Charlton** , 1983) . For the same reason , I accept here that the verb cause correlates with the following phrases :

**Make somebody do something .**

**Persuade somebody to do something .**

**Urge somebody to do something either by force or persuasion .**

**Induce somebody to do something .**

**Force somebody to do something .**

**Compel somebody to do something .**

This does not mean that the definition of causativity/Causality offered earlier in this paper is not valid . On the contrary , it is the basic definition for the phenomenon but after investigation , it has been noticed that causativity is a wide topic which covers many factors and notions which have not been accounted for at the introduction of this paper . Such notions and factors have been noticed later on in the study where some of them emerged by examining the relation between logic and linguistics in regard to causativity .

In a causative situation , in most cases , there is a motive behind the causing action which leads to the event . This motive is an act which is either intentional or non-intentional . The result is always achieved when the causing action occurs in the past , (see sections 2 and 3) i. e. when the verbs of the causing action have the past tense . When the action is in the present or the future tense , the sentence does not assert whether the result is achieved or not . Consider the following sentences :

1a. John killed Harry .

b. John is killing Harry .

Sentence **1a** may indicate some ambiguity as to whether it emphasizes that Harry died as a result of killing or he was killed by John and not by any one else . In sentence **1a** the hearer infers that it is confirmed that Harry was killed by John and he was dead . Whereas in **b** one can infer that John is going to kill Harry or in the process of killing Harry where the action has not taken place yet nor has been completed , i. e. it does not assert that Harry died as is the case in **1a** . Sentence **1b** is offered here because it is difficult to think of a context of the kind below :

c. John kills Harry .

## 7. Conclusions

In this paper the issue of causativity has been examined as a logical and philosophical phenomenon in a way which corresponds to the linguistic theory.

Causation is an outcome of many causal factors which are dependent on human logical information of different states of affair in real life, as causativity is associated with truth values. This relation may answer the question why factivity is related to causativity. Causation in this sense is subject to some philosophical analyses. Logical structure, semantic structure and logical semantics are terms that combine the idea of meaning with the use of syntax. They play an important part in causativity by deciding the acceptability or unacceptability of causative sentences. Logical equivalence is not semantic equivalence though they are interdependent and mutually affect the structure of the English language.

A causative action which occurs in the past tense holds a factive presupposition of its complement as the event is certainly achieved unlike the case in the present, imperative or future which does not hold factive pre-supposition since it is not clear whether or not the event is produced.

Duration is an important factor in causativity. It affects achieving, promoting, preventing or postponing a causative result, i. e, the length or shortness of the time needed for an action to produce an event is significant. There is also a slight durational difference between a cause and an effect. The first precedes the second in duration, because the causing action (when it occurs) needs time to produce an effect which leads to the resulting event. The nature of the cause-effect relation may justify why causation is a forwards and not a backwards phenomenon in terms of time.

Causality can be expressed in different ways and there are different notions for causality which are all ruled by **CAUSE**.

Non-lexical causatives explicitly express a causal link between the agent, the causing action and the result; unlike lexical causatives where causativity is implicitly expressed and that is why causativity is associated with other linguistic phenomena.

A logical approach may allow the treatment of a phrase through a direct semantic way (which does not ignore the syntactic aspect). An approach which offers a treatment that combines language and logic by accounting for semantics, syntax and truth values is assumed to be successful when applied to a certain linguistic phenomenon in two languages. It may contribute to both in the same way or in different ways or may contribute to one and fail in the other. Such matters make

good hypotheses to be examined in future studies which may be of interest to all those concerned in language analysis , teaching , contrastive analysis , error analysis , text book writing , semanticists , logicians , etc.

*In this paper , some of the ambiguities surrounding the theory of causativity or causality and other associated matters have been clarified . A new theory has also been introduced in this paper . Its adequacy is a matter to be judged by readers . The findings of this paper will hopefully be developed in future studies and the theory will be found useful for treating problems arising from the use of semantics and truth values . A wholly invalid theory is , of course , of no utility , but it does not follow that a valid theory is useful in any application .*

Though this paper has examined several issues associated with causality but unresolved questions remain . Such questions concern areas like ambiguity , and cause-effect relations .

The central theme of this study as well as those of other associated problems are complicated and not easy matters and thus , before the conclusions of this paper are confirmed , modified or discarded , more data and analyses are needed . Some areas related to other fields can be tackled through semantics . However , semantic methods of teaching need not replace the teaching of grammar but complement it . Future research on such issues needs more than an expanded inventory for initial data collection . It also requires the flexibility in the type of data to be analyzed in order to allow the analysis to generate hypotheses which can be tested and elicit further studies . The findings of this paper seem to provide working hypotheses for further research in the field in developing a better understanding about causality , related linguistic matters and truth values .

## Notes

1. This is according to **Fillmore's** (1970) case grammar and **McCawley's** (1968 and 1971) theory of "**predicate raising**".
2. The capitalized **FORGET** indicates the semantic structure underlying the surface verb **forget**. The symbol **S** stands for the proposition underlying the surface manifestation of the sentence. For more details see **Yamanashi** (1972, 388-410).
3. I would suggest, instead, the predicate **<COME ABOUT THAT X DOES NOT REMEMBER or CEASE TO REMEMBER>** rather than to know because **X** knows but does not remember contrary to **Yamanashi's** (1972) claim.
4. **T<sub>1</sub>** here refers to time in a particular moment, i. e. when one cannot recall his/her memory at a particular time.
5. I am not going into all the details of **Von Wright's** theory. I, only summarize very briefly what is relevant to this paper. For more details see **Von Wright** (1963, 1968, 1971, and 1974).
6. **E** and **F** represent what **Good** called "**tendency of cause**", **Q** is a measure of a statistical relevance of special properties which he did not specify. **Q** must be conditional on **U** and **H**, i. e. depending on them as alternatives to **E** and **F**.

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