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Ontological causality as the demarcation criterion of scientific & philosophical fields: *things* and *objects* vs. *criteria* vs. *processes*

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Summary

This paper follows an interdisciplinary approach through at least three disciplines, i.e. logic, ontology and sociology (of expertise). Its aim is to provide a useful tool for the fields related to the study of expertise to demarcate the various scientific fields. In the process several issues are also addressed; issues such as causation and negation that are equally important for this discussion, but current literature does not and maybe cannot cover.

Keywords: ontology, logic, expertise, causality

Introduction: what is an "ontology"?

When we refer to the ontology of a certain scientific field, we mean its basic constituents, i.e., things, concepts, parts, places etc. that make up that said field. Ontology is a prerequisite for any scientific or philosophical field to exist – even if this ontology is hypothetical (UFO's and gravitons) or metaphysical (identity, universals, etc.). Without an ontology, there cannot be a field. Ontologies are *sine qua non* for the existence of any field, and they take up all the room regarding the research performed there. For example, in biology, the basic ontology includes entities like cells, tissues, mitochondria, DNA etc. In ethics, the basic ontology includes good, bad, consent etc. Some of the answers we shall attempt to sketch in this brief article elucidate questions such as:

- can we find systemic criteria to demarcate knowledge fields?
- *discreta* vs. *continua* in ontology: how to handle them?
- what is the nature of causality that governs the relation of the various ontologies, i.e., of the various entities that make up the various fields?

What is a vertical ontological relationship?

So right here, we may make a first categorization, called *vertical ontological relationship*. For example, hierarchy-wise a mitochondrion stands in the middle exactly before the cell and right after ribosomes (mito-ribosome). In sociology (where the basic ontology includes society), society stands in the middle exactly before a nation and right after a group of people. We must admit here that these entities in the vertical axis are also connected with some kind of direct causal relationship: ribosomes directly affect mitochondria which, in turn, directly affect cells – and vice versa. The same goes for society, nations and groups of people.

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There are limits to this causal relationship. For example, we may already see that even though it is very probable that groups of people may affect the nation, and ribosomes may affect the whole cell, this effect is not so immediate or always as powerful as in the effect such entities exert on their immediate neighbors. An organ failure may immediately and strongly affect an individual, while cell apoptosis will hardly make any difference to the same individual. However, in this vertical hierarchy, there are entities that clearly have no direct, let alone predictable, impact at all. This can be seen especially when going through various scientific fields; for example, atoms make up matter and cells are made of matter; cells make up humans and humans make up societies. However, there is not a linear vertical chain-like causal relationship between atoms and societies – none that has any practical significance at least because yes, if we eliminate all atoms, we eliminate society as well and indeed the atomic bomb explosion greatly impacted the society of Hiroshima: here, by implication, we have a powerful example of the contrasting asymmetry between affirmative and negative relationships. Establishing such relations might get us somewhere; otherwise, no further targeted elaboration is possible.

In brief, there is a primary apparent symmetric systemic duality in stating something and its negative: at first sight, affirmative statement *p* matches pairwise, or one-to-one, to negative statement ¬*p* (not *p*). On the other hand, though, if we are to top this with a logical discussion, obeying the requirements of research bearing results, we must carefully and explicitly determine what particular significance we attach to this negation: are we saying "I do not contend that *p*", or are we saying that "I contend that not *p*"? In the bottom line, simply put, which is it that we are are we refuting? Is it the verb or is it its complement (meaning, at least syntactically, its predicate or its object)? Are we not stating or are we, so to speak, "un-stating"?

Going back to the line of approach of this paper, these relationships, even though they are part of a, so to speak, logical hierarchy (atoms, molecules, proteins, cells, organs, humans, societies), their linear sequential causal relationship continuity is so week that we cannot even claim there is any. If there is any causal relationship (e.g., between atomic bomb explosions and societies), it may be called a *horizontal relationship*.

What is an horizontal causal relationship?

Let us see another example. Inside the cell, apart from mitochondria, there are also lysosomes. Both have vertical causal relationships with the basic, zero-level entity of biology, i.e., the cell. Lysosomes and mitochondria exert an even smaller causal relationship towards each other. Even if lysosomes disappeared, mitochondria could remain almost intact, until the whole cell should collapse affecting mitochondria as well. This is a horizontal relationship.

The criterion differentiating the horizontal causal relationships from the vertical ones is not always extracted from the phenomenon itself. Even in the case of mitochondria and lysosomes, one should expect direct metabolic pathways linking one to the other. It is a matter of function, or how we define it, or how it pleases us to view it (as long as our approach is consistent, productive and elegant). Here we find again one of the most important – if not *the* most important – issue of Classic Epistemology: the problem of the continuum. Again, the answer is the same: no continuum of processes (where at one extreme there is one effect and on the other extreme there is another effect) will "speak on its own accord" towards informing us where the boundary lies; we have to set this boundary based on, e.g., working hypotheses, conventions and assumptions.

All these classes of vertical and horizontal entities, concepts and procedures exhibiting direct causal effects on the main (zero level) entities of a field, comprise and delineate both the ontology of that field and the limits of that said field. All entities affecting one another do not necessarily belong to the same field (e.g., bomb and society); however, if no vertical or horizontal relation exists, then such entities definitely do not belong to the same field. Therefore, we may see here a negative demarcation criterion: what *does not* belong to a field or what *cannot* belong to a scientific field. For all other cases, there will always be levels of belonging.

Objects vs. Categories

As we are discussing the broader horizontal plane of entities, procedures and phenomena, an atomic bomb detonates. Mitochondria immediately evaporate in the most causally direct way possible. Does the bomb belong to the ontology of, say, biology, or of sociology? Note that the bomb also wipes out societies! There is a problem here; a problem affecting abstract theoretical fields even more so than applied fields such as biology. By saying "whatever entity has a causal relationship with other entities within a given ontology" we never meant that whatever has a causal relationship with a certain entity automatically belongs to the said ontology. And here is an instance where it starts to make a vast difference whether we are saying "there is not a detectable causal relationship" (one does nothing to the other / is irrelevant) or "there is a detectable opposite relationship" (one undoes the other / is adverse).

This leads our discussion to the epistemonic method, i.e., the method of epistēmē, including its most characteristic fundamental keynote methodological features: the basic duality of the analytical method, juxtaposing and comprising analysis and synthesis, as paired with the abstractive method, likewise doing the same with abstraction and structure (K. G. Papageorgiou & Lekkas, 2021). It also brings it to issues pertaining to what we refer to as Theoretical Epistemology. As a small recapitulation, the abstractive nucleus of the method of epistēmē is supposed to have been linked by a direct isomorphic analogy to set theory since the first period in which this whole revolution was laid out and formulated mathematically, i.e., the multiple mathematical revolution at the end of the 19th century; and that is our own rudimentary staple abstract methodology, contingent on categorization.

When we are talking about *analysis*, we are, in essence, *decomposing* an "object", whether physical or mental, into ("its") "constituents"; and when we are talking about *synthesis*, we are, in essence, *composing* "constituents" towards an "object".[1]

We may conceive then an element which may be broken down (analyzed) to more components or ingredients and so on and so forth until we reach basic elements that are not further analyzable. Of course, this is not because "reality" forbids us but because we have selected a delimiting condition ourselves – for example, in biology (but not in molecular biology) we have decided to deal with entities up to the point of e.g., amino-acids. By no means does this imply that amino-acids cannot be further broken down analytically into molecules, atoms, subatomic particles etc. Our standing point is a matter of our own epistemonic choice. However, anything smaller than e.g., an amino acid does not literally belong to the ontology of biology the same way anything smaller than electrons, protons and neutrons does not belong to the ontology of chemistry. So, this is analysis; and synthesis occurs when we go from such fragments back to whole elements – in the special case that we reconstitute the same element, then we have re-synthesis (Gr: *anasynthesis*). For example, we can dismantle a car and with its parts construct (synthesize) another machine *or* even the exact same car (resynthesis).

What do we destroy then with an atomic bomb? With atomic bombs we eliminate a society but only analytically (e.g., the society of the people of Nagasaki) and not structurally (the concept or the *criterion of inclusion* called "society"). Indeed, as V said in the movie "V for Vendetta": "I am an idea, and ideas are bulletproof". No atomic bomb can destroy an idea; even if all humans perish, even then, one could make an argument about ideas existing at an independent plane – not our issue here. So, society, structurally, cannot be destroyed by an atomic bomb: it is a label, a criterion for inclusion in the set of everything that fulfils whatever criteria we think for anything to be called a "society". One of the major failures of science is exactly this division between analytic and structural elements.

All structural concepts are such criteria, ergo we are now in the realm of the second pair, abstraction and structure, which deals with sets and their relationships of inclusion. Abstraction corresponds to the inclusion in supersets. Here the element {*car*} may be included in the nested supersets of FAM-

1. Latin words *componeo* / *compositio* are the precise equivalents of Greek *συντίθημι* / *σύνθεσις* (*syntithēmi* / *synthesis*).

ILY CARS, MEANS OF TRANSPORTATION WITH WHEELS, MEANS OF TRANSPORTATION – or even in many other much more structural analytical categories. In abstraction we abstract meaning by extracting, and setting aside, and removing from our definition, nested sequences of properties, which, deep down, are nothing other than criteria towards including elements or subsets into sets or supersets. In structure, we follow the reverse route, from more general sets to sub-sets. So, abstraction in CAR (the criterion of inclusion, not a particular motor vehicle) would be like asking for a car that has the qualities of being FAST & FURIOUS, SUITABLE FOR FAMILIES and CHEAP. In philosophy too, the concept of "property" is a subset of "category of thought" and the superset of *ante res* universals, and *ante res* realism. However, our point is that it is easy to see a philosophical idea as "abstract", "immaterial" and maybe "indestructible", whereas it is much more difficult to be conscious about what exactly it is that we are referring to when talking about "car": is it a [CAR] as in an object, a *thing*, (Latin: *res*), a synthetic entity that has material existence, mechanical nature and a license plate, or is it the abstract concept of CAR as a criterion for inclusion in the homonymous category?

By all means, causality works when referring to analytic elements. Abstract-structural concepts are viewed as sets and their inclusion criteria and set-relations is what interests us. For example, the set HEAT and the set BURN may have an inclusion relationship: abstractly speaking, BURN is a subset of HEAT, therefore, one could identify this as a causal relationship: HEAT causes / includes / precedes BURNS. More on the causal relations, later. Of course, what needs to precede all these is a set of clear definitions regarding every term, and the essential common agreement that what we mean by a certain term is understood by all as being the same.

Demarcation criteria

Demarcation is already an important subject in the sociology of expertise when referring to identifying experts, i.e., who is an expert and who isn't (Collins & Evans, 2007). Here, we seek demarcation criteria for scientific fields, which carries a dual question: how scientific fields are recognized and what are the boundaries of these fields. Can we be objective in selecting the ontology of our scientific and philosophical fields? If yes, how? If not, what does this mean and entail regarding the validity of the content of the various fields?

As was mentioned before, there is no "objective" way in which to demarcate specifically and uniquely anything that is a part of a *continuum*. This leaves Western thought baffled, since the other alternative viable solution would be subjectivity; but that is unsatisfactory. Hence, Western scholars argue, we *must* find an objective way in order to demarcate objects, phenomena and concepts. Phenomena should be able, somehow, to reveal to us, e.g., when it is that someone losing hair becomes bald! The history of Western thought is a celebrated effort to ask scalps of heads to tell us when they are hairless enough for us to categorise them as bald. However, as we have repeatedly argued, in epistēmē there is still another category: theoretical. Theoretical "things" are neither objective nor subjective. They exhibit a different relationship to us. Being abstract, they are intersubjective, but not in the "objective" meaning of the word. Therefore, the answer is in the affirmative regarding our ability to demarcate domains if done on a theoretical level (which is relevant for us, in contrast to, say, subjectivity on one hand, which is not general enough for us and objectivity on the other hand, which is relevant but infeasible anyway).

Experts, in the sense of specialists (and not in the sense of generalists), are very fond of some rigid idea regarding our ability to demarcate both experts and fields; unfortunately for them, it "ain't necessarily so". Experts, then, are called to be conscious of whatever entities the ontology of their field contains, why it contains these specific entities and under what assumptions.

Some remarks on causality

There are many types of causality[2] and usually applied sciences use a different understanding of causality in relation to mathematics; the former

2. See "Types of causes" here: https://evalc3.net/background/describing-causes/ (accessed 15-8-2022).

adopt an empiricist approach and the later a theoretical approach. The empiricist approach has, as one would expect, its foundations in Hume's ideas and work (Beebee, 2016; Mahoney, 2008). In (applied) science many have identified problems related to both Humean and other approaches to causality (Anderson, 2008; Cartwright, 2006; Harbecke, 2021; Salmon, 1997). Here we shall take a step back and see what an abstract theory of causation should look like before anyone even attempts to interpret it for the world; its mathematics and its philosophical implications before going any further. In essence then, in mathematics, causality may be said to *sometimes* be symbolizable as:

$$A \to B$$

which is *not* causality (ontologically), it is just an abstract relation meaning *nothing* but which may in turn *be interpreted as* causality when and if possible and under strict conventions.[3] This relation gives us just the *methodology* of causality through some signifiers without telling us anything about the signified. The signified stems from the world. At that level (reality) the ontological status of causality is conventionally set without any regard to the equations of mathematics. Only after one makes up a "narrative of causation" inside their head they will apply it to some causation-related mathematical equation and see how far this gets them in terms of consistency with the theorems, the axioms etc. The methodology of causality that has been developed though the various equations and inferences in logic is then used as a troupe; a theater company. The actors remain always the same, but one can use them in different ways to put on various shows. The crucial point is that one first develops a methodology for causality, and only afterwards should they attempt to apply it to world phenomena – or even better, to attempt to fit world phenomena to these mathematical archetypes / models the same way one buys shoes: they will go to the shoe-store and choose the pre-existing shoe with the best fit.

The problem with the natural sciences is that they have confused *information* with *mechanisms*. Observation is the cause of information, not the cause of mechanisms. The latter cause is deterministic whereas the former cause is probabilistic / statistical, especially when there are many observations to be taken into account. One cannot simply infer mechanisms through observations of phenomena, let alone create mathematical models in order to describe the said observations. From the start, formal logic absolutely prohibits inferring effect from cause, unless, in the specific instance, a uniqueness of cause can be substantiated and has been proved in advance. An excellent example of this type of fallacy is the way non-Euclidean geometries have been developed (directly from observations). Science constantly sets up causality models that are effects of effects which then calls them "causes".

Now, let us briefly examine the concept of interpretation. The process of interpretation is actually the process of name-giving. Hence, $A \to B$ may be literally called a gateway to causality when we give the name of "cause" to "A", of "effect" to "B" and of "causality" to "$\to$". If it is to be *successfully* called causality, then this relationship between and should provide us with a consistent system, but *not without* any limitations and in any context and scope. For example, we must reflect on the question that if $A \to B$ is called a "causal relationship", i.e., A is the cause of B, what does the following mean?

$$A \leftrightarrows B$$

Does it mean that A is the cause of B and B is the cause of A? Always? Certainly, that cannot be the

3. Conventions (a huge matter on its own accord) serve as anchors in our theoretical systems. They are not objective but should nevertheless be "objectively accountable". Therefore, once we have agreed to "go by them", they are binding for us *as if* they were objective until we decide to change them. We cannot carry on a "grapple" into a subject when each one of us freely picks them up or leaves them out, circumstantially including and excluding them, at each different instance. To that end, they also need to be *refutable* – but solely by declared and institutionally acknowledged and approved consensus. Conventions are necessary and important tools, but failure to understand their deeper status and sense leads us to sometimes ask too little of them and sometimes too much.

case. Hence, we must be careful as to the limits of our proposed interpretation.

As we have already mentioned, it is up to us to determine causal relations in the real world. What is causality ontologically? Is it about two events occurring in close temporal and/or spatial succession? Do any two events that have this characteristic have a causal relationship? Let none of us forget here the two related informal fallacies called *post hoc ergo propter hoc* and *cum hoc ergo propter hoc* ("after this, therefore because of this" and "with this, therefore because of this" respectively). Many philosophers have tried to provide useful heuristics in order to identify causal relations in the world (from Aristotle to Scotus); but all of them identified reality as the direct source of knowledge about causation. As we have pointed out in (K. Papageorgiou & Lekkas, 2020) it is always up to *us*: *we* are the ones selecting and accepting the criterion when considering what to call a "cause", not the perceived information about some observed phenomenon, even though the phenomenon may offer us some hints or ideas (always in the form of information) about what the "real" causal relationship may be. These seemingly simplistic remarks are usually not taken into consideration when we refer to "logics" and "quantum causalities" where, apparently, we are only too eager to let the phenomenon dictate the mode of causality rather than going on and interpreting the abstract causal relationship ourselves based on a proper methodology. Usually this happens because we simply wish to find *one* formulation for every application without any limitations; and that is something that cannot be done: typically, *there is no one universal solution*. Then, the quest for demarcation criteria for scientific and philosophical fields based on ontological causal relationships is reduced to the mere identification of limitations in what we may call the *scope of causality* in our specific case. And right there the criterion starts to come out as circular.

A word about *continua*: sometimes the ontology of certain fields includes entities or concepts that span across a (countable or uncountable) area of values – take for example real numbers or a spectrum in physics. As much as it is necessary to define (simple and full) nuclear statements in first order logic to deal with *discreta*, in the world of continua (which are infinite sets by definition) one is potentially in need of *n*-level inductive logic, starting off from "level-1" inductive "predicate" calculus entailing single use of the two conjugate inductive quantifiers: primitive $\forall$ (*for all*) and derivative $\exists$ (*there exists at least one such that…*), defined within the theory as $\neg\forall\neg$ (*not for all not*).

Two case studies: the Distal Method and the Ethical Epistemology

The Distal Method

As additional examples let us take a look at two new fields: the Distal Method, which is both a Paradigm (a novel approach) and a Research Programme within the broader field of the Science of Exceptional Achievement and Ethical Epistemology, a new subfield of epistemology.

We have already discussed some things about biology, which is a model-field, a perfect case study for our discussion. The cell is a very well-specified entity and the various entities that are related to it (its constituents and the larger structures it is a part of) are, or may become, "clear-cut", easily identifiable with trackable effects they exert to each other. The Distal Method is a multidisciplinary approach to expertise attainment, having both material and immaterial constituents, and Ethical Epistemology is a purely immaterial domain of knowledge. Note that "material vs. immaterial" is not the same as "analytic fragments vs. structural components": for instance, knowledge is an abstract notion; but, if we refer to a specific piece of knowledge, then it becomes an analytic component.

In Distal Method the basic ontological entity is the concept of *distal adaptations*, i.e., all mechanisms that are responsible for long-term, hard to change effects. Distal adaptations ultimately affect *hard* learning (*learning*, which is difficult to acquire vs. *performance,* which is a short-term adaptation leading into *soft* learning, but not into deep, radical long-term performance gains, i.e., learning). Distal adaptations are the effect of non-continuous changes, i.e., changes that are beyond the current capacity of the individual. In turn, the distal adap-

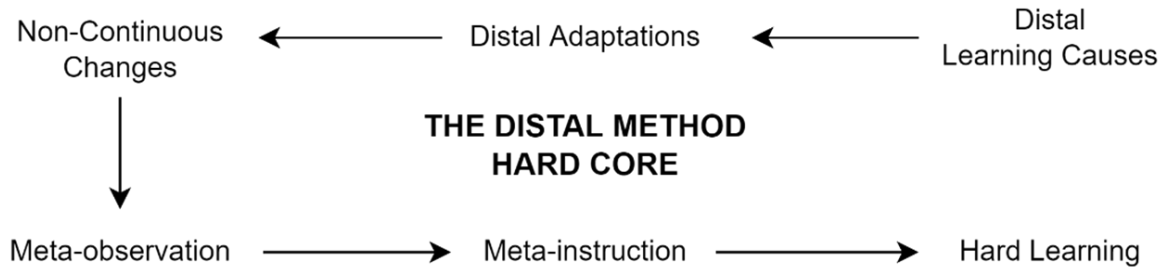

Fig. 1 The Distal Method Hard Core.

tations are caused by the *distal learning causes*. The relation here may be described as follows:

$$HL \subset MI \subset M0 \subset NCC \subset NCH \subset DA \subset DLC$$

Where, DLC stands for *distal learning causes*, DA stands for *distal adaptations*, NCC stands for *non-continuous changes*, MO stands for *meta-observation* (observing the present having in mind the distal causes of performance), MI for *meta-instruction* (instructing in the present having in mind the distal causes of performance) and HL stands for *hard learning*. All the above-mentioned concepts apply, i.e., the vertical causal relationships among these entities, the possibility to identify entities that are horizontally related to each of these central concepts, all these forming the ontology of this area of study and at the same time justifying its existence. The relations are shown again in a different form in figure 1.

The Distal Method has many tools for expert learning, for mental skills training, for physical conditioning etc. However, such tools do not constitute the ontology of the Distal Method since they can just as easily be used in other fields / domains / systems. In order for something to constitute a separate field, an exclusive core ontology must exist at one hand, and on the other hand the vertical and horizontal causal relationships must be presented. Of course, the peripheral ontology can and will include more entities; after all interdisciplinary systems (such as the Distal Method) incorporate findings, concepts and ontology from other disciplines – in this case from Kinesiology, Biology / Sociology of Expertise, Pedagogy and others. However, core ontology should exist that is original, unique and meaningful (in that it may be offered as a substrate for expertise attainment in that field).

In the following figure 2, one may see the various horizontally related entities comprising the multi-disciplinary field of the Distal Method. One may identify vertical relation as well, but this detailed work is outside the scope of this paper.

Ethical Epistemology

In Ethical Epistemology, the basic concept is that of *virtuous knowledge-structure* (VKS). This leads to Ethical Epistemology, which, in turn, leads to epistēmē, the latter being the central category in what may be describes as "logically structured knowledge about physical reality". For comparison, the other knowledge system that has (wrongfully) prevailed, science, is defined as "empirically structured knowledge about physical reality". In relation to epistēmē then, but also in relation to ethical epistemology the following relations may be identified:

$$\text{Virtuous Knowledge Structure} \rightarrow \text{Ethical Epistemology} \rightarrow \text{epistēmē}$$

Again, in this area of study, epistēmē is a result (subset) of ethical epistemology, which, in turn is a result (subset) of virtuous knowledge structure. Ethical epistemology is not the same as Virtue Epistemology; the latter holds that it is the knowing subject who, having certain epistemological virtues, is able to produce good-quality knowledge (so to speak), while the former holds that the structure of epistemology *per se* has considerable

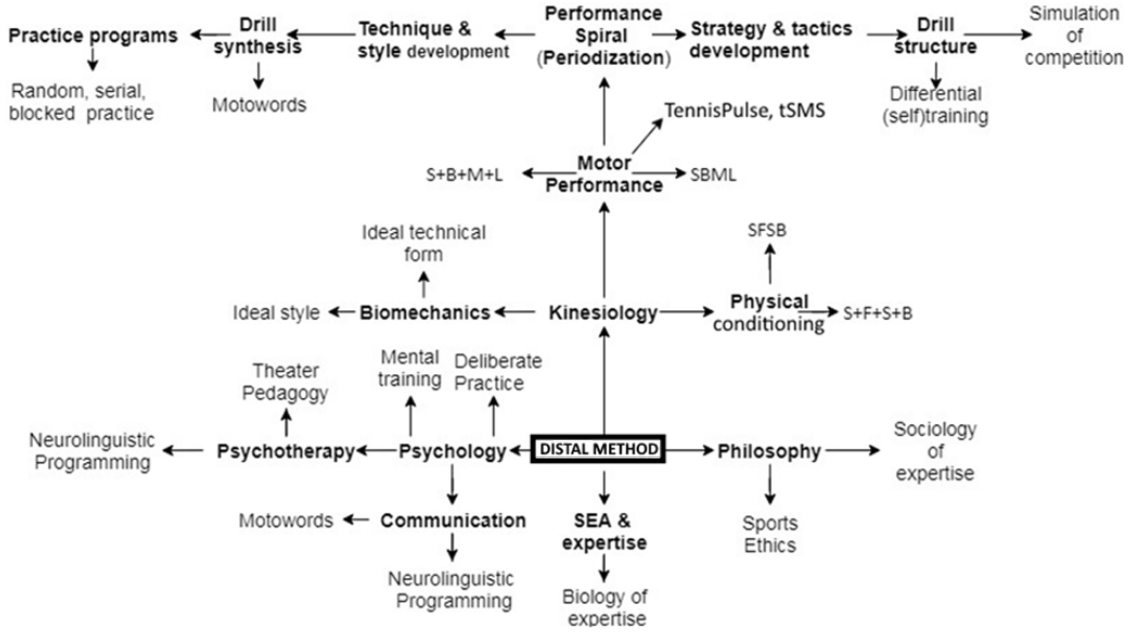

Fig. 2 Various horizontally related entities comprising the multi-disciplinary field of the Distal Method.

ethical implications, even at a theoretical level (e.g. it is unethical to evaluate a theory based on experiments). Terms and concepts, such as that of "theory" may be related to still other fields and domains, the same way (analytically) a cell belongs to the ontology of biology, medicine, sports science etc. It is the unique "structure" (in Ethical Epistemology regarding *knowledge*) or "synthesis" (in biology regarding *cells*) that demarcate each domain. These structures and syntheses (or compositions) are brought together in our minds due to hypothesized specific relations. However, ontology *per se* cannot be demarcated. One could go as far as saying that demarcating ontologies of *specific* scientific fields is the responsibility of expert specialists, whereas the relations of not closely related (or vertically related) ontologies among different domains are dealt with by expert generalists (K. G. Papageorgiou & Lekkas, 2020). This has been shown to be the case in, e.g., the COVID-19 pandemic, where there is an apparent lack of expert generalists from expert panels: individuals who can and will simultaneously appreciate the ontologies related to the pandemic from various standpoints (medical, ethical, political, historical etc.).

Conclusion

All in all, this paper has hopefully started a conversation in the epistemological foundations of expertise and the importance of having a sound system of logic and of set theory for this discussion. Different scientific fields are usually demarcated by chance, i.e., historical necessities and social needs; a more formal process of identifying them should be in place and this paper presents such a model. The restrictions of this approach include the eluding nature of the ontology of many established fields of study; however we consider it as a challenge for future researchers (...expert specialists) to delve into the specifics of the various fields and clarify their structures. Expert generalists, meanwhile, should deal with the theoretical implications of this approach.

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