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# A psychological field model of scientific method[1]

*Un modelo de campo psicológico del método científico*

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## Resumen

Este articulo intenta delinear un programa para la investigación de los conceptos de la metodologia científica en términos psicológicos. La suposición general es que el método de la ciencia implica descripciones de tareas; y que como estas tareas comprenden al mismo tiempo actividades de los individuos, seria posible considerar a los conceptos del método como referencias de las actividades realizadas por los cientificos. Sobre la base de esa suposición general, se utilizan las categorias aportadas por un modelo de campo psicologico con el fin de presentar diferentes ejemplos de su identificación en algunos conceptos metodológicos, y proponer un tipo de descripción del método que podria ser obtenida con tales categorias.

Palabras claves: modelo de campo, actividades individuales, método científico, tareas científicas

## Abstract

This paper outlines a programme for investigating scientific methodology concepts in psychological terms. The general assumption is that scientific method involves descriptions of tasks carried out in science; and because these tasks involve activities of individuals, it should be possible to consider the method's concepts as references to

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scientists' activities . In this analysis, categories provided by a psychological field model are used to present different examples identified in methodological concepts, and to set forth the type of description that should be obtained when using these categories.

Key words: field model, individual activities, scientific method, scientific tasks

Different aspects and components of science from a psychological standpoint have been discussed in the literature (e.g. Langley, Simon, Bradshaw & Zytow, 1987; Gholson, Shadish, Neimeyer & Houts, 1989; Lovie, 1992; Campbell, 1989). Among these components the methodological aspects are emphasized here. The assumption in this paper is that scientific method involves descriptions of tasks developed within science, and because these tasks involve activities of individuals, we consider the method's concepts as references to scientist's activities. Any inference made from the data, any research plan, or any effort to collect empirical data are activities of the scientist that can be referenced and summarised as "methodological concepts". These methodological concepts include data collection tasks, research designs, and analysis techniques. Some concepts refer to correct activities of science while others refer to failure, as happens both in the so called valid and non-valid designs. Some concepts refer to particular scientific activities such as data recording or frequency counting, and others describe a broad range of activities such as research designs. In short, there are many ways of referring to the scientist's activities in terms of methodological concepts. That is why we can assume, from a psychological point of view, that scientists' activities can be shaped through generations by means of successive attempts and developments, and that methodological concepts involve the activities carried out in contemporary scientific endeavors. Understanding the concepts of scientific method as they relate to the activities of scientists implies to study science from a psychological perspective.

Some methodological issues are already explicitly set forth in psychological terms, such as those issues related to the perceptive processes of the researcher (Fassnacht, 1382; Muchielli, 1974) and the mutual influences between the researcher and the subject studied (Haynes & Horn, 1982; Jung, 1982; Rosenthal, 1966; Rosenthal & Rubin, 1978). Other concepts, such as research designs, have been defined as the researcher's "action plans" (e.g. Arnau, 1986; Kerlinger, 1973; McGuigan, 1963), although they have not been explicitly described in psychological terms. As it occurs in designs, as well as in other aspects of scientific method, the main configuration is often defined in formal terms without referring to human activities. Logic, mathematics and statistics are three significant aspects in contemporary scientific domains that do not refer to psychological components. Such systematic absence probably results from a specific notion of what is methodologycal. It is conceivable that the formal representation of many methodological concepts has contributed to preserve the notion that these means of expression are of a special nature. It may be that by working with what is formal, human practices are forgotten and a radical separation between both aspects is taking place. There is a tendency to think of the existence of what is methodology in itself regardless of individual's behavior, as if it were part of an aprioristic existence related to a reality of different nature from that of human activities. Along these lines, methodological concepts are to a certain extent reificated, and one talks of designs and methods as if they were beings or realities with their own existence. Furthermore, the normative character set forth for methodological concepts is often accepted as something inherent to them, without justifying nor considering what could be the basis for such a capacity.

From a psychological perspective, on the other hand, developments in methodological concepts do not need to be incompatible with studies of the activities involved. Eliminating these psychological components does not prove that they are irrelevant. Even though methodological development has made us forget the psychological aspect of science, recovering such a component would be legitimate. It should be possible to track the psychological aspect in methodological concepts because the latter are developed and used by humans. Although methodological concepts have been set forth mainly in formal language and developed according to formal rules, it is possible that both aspects reflect and express psychological patterns. Methodological concepts are possibly molded by the forms and criteria of the rationality that researchers use, for instance, when they accept some inferences as reasonable. It seems possible to track how methodological concepts are linked to psychological criteria and processes. From this approach, the meaning of methodological concepts is not inherent but describes the activities of scientists. For this reason the normative character of science derives from the descriptions carried out; and the current methodological concepts regulate or prescribe the scientist activities because they have described them before, and not because the concepts are of a special nature that in itself and a priori have such a capacity.

The present psychological approach does not intend to exclude methodological conceptions. Our objective is different; first, we aim to contribute to the study of science and its method. Just like logic, mathematics or statistics, we believe psychology can make contributions to methodology. Possibly, one can discover in the method certain aspects that have not been taken into account by other approaches. Although is difficult to predict the exact contribution that will be achieved, following a different path may increase the possibility of gaining new knowledge. In addition, this path could bring forward some advantages to contemporary methodology, for instance, the ability to structurally define methodological concepts. There have been many developments in method but certain aspects could be further developed and structured. As happens with data collection and analysis that are described in different terms and parameters, there are overlapping subject matters instead of integrated ones; there are aspects which are developed in some areas, while others are completely overlooked. For example quite a lot of knowledge on experimental designs is not applied to correlational methodology. Moreover, there are characteristics germane to certain concepts, such as the properties of a category system, that are unexplored in other subject matters. These and other cases could be integrated if they could be seen as specifications of more general concepts. Further, they could be psychological if their components were, in fact, identifiable within methodological concepts.

There are some assumptions underlying to the proposed task. First, we assume that psychological processes are similar within scientific and nonscientific environments. It does not make sense to think that scientists exercise cognitive and behavioral processes different from other humans. There is no reason to speak of situations of scientific life as special and of different quality than the non-scientific ones. Many working and social situations demand similar approaches than those of scientific situations. The organization and validation of knowledge based on observable data takes place within as well as outside science. And even though both tasks occur more systematically and explicitly within science, this should not imply different psychological processes.

The idea that a correct science has to be exclusively described with formal models, and that psychology can only explain deviations from the norm is rejected here. This would be equivalent to saying that by producing good science the individual becomes a special being portrayable in nonpsychological terms, whereas his human condition is expressed only through the mistakes made. On the contrary, a psychological approximation should attempt to take into account the different performances of the scientist, whether successful or unsuccessful, individual or collective, whether testing, generating hypotheses, or obtaining and organizing knowledge. In brief, any task developed within science should be encompassed by the concepts of scientific method.

## Introduction to a psychological field model: categories

Different psychological perspectives and theories can make varied contributions to the study of scientific activity. Each of them, by focusing on specific aspects and problems, can give a different description of a scientist's activities. The position underlying the present approach is called Inter-behavioral Psychology and Psychological Field Model. This approach was built upon the proposals made by Jacob R. Kantor (e.g. 1924-26, 1958), and developed in the past years by a number of theorists (e.g. Caracciolo, Moderato & Perini, 19[illegible], Fox, 1990; Hayes, 1992; Lichtenstein, 1988; Lyons & Williamson, 1988; Mahan, 1987; Morris, Higgins & Bickel, 1982; Ribes, 1990; Ribes & López, 1985; Roca, 1990; Ruben, 1986; Sonoyama, 1992; Walker & Dumas, 1989).

### *Individual-environment interaction*

In the psychological field model, the smallest meaningful unit for psychological analysis involves the interaction or mutual relationship between each individual and the events or objects from his/her physical, ecological or social environment; it does not seem adequate to break this unity. Natural language is a permanent reference to individual-environment interactions, and mention to the subject's actions will only make sense if it is in relation to an aspect of his/her environment (e.g. one talks about something, one solves a problem, one walks on a surface). Additionally, what is considered an element of the environment is always seen as such by someone, and it is only in relation to someone that events or objects acquire a meaning. The existing world acquires psychological meaning only when we make contact with it. The elements of the environment are important when talking about the individuals' activities. In the same way, individual activities are necessary to refer to elements of the environment. The relationship between these two is, therefore, the smallest meaningful unit of analysis, and any methodological concept should be understood from this model. For instance a variable is a concept, and each concept should be understood as a relationship between the individual and his/her acting environment, and not as something exclusive to the subject. In the same fashion, a scientific fact should not be understood as exclusive to the environment, but as interacting elements of the environment and individuals.

Adopting the individual-environment interaction as the unit of study enables to move beyond the limitations of the analysis one-way relationship among these elements. Our interest is not only on studying the individual's influence on the environment, nor the influence of the environment on the individual, but also the relationship between them. Studying the interaction as a unit means focusing on how the bidirectional influence between individual-environment is organized in any particular episode analyzed. The organizations of these interactions have been classified by Ribes & Lopez (1985) according to their level of detachment from the physical-chemical and spatial-temporal properties of the situation. This refers to the individual's ability to interact increasingly less conditioned by such properties. Thus detachment is the defining feature of psychological behaviour versus biological one. Biological behavior by definition is fixed, invariable, and not detached. The subjects respond in the same way to same stimuli, as it occurs, for example, in the non-conditioned responses of Pavlovian conditioning. Detachment, however, begins when biological reactivity is modified and the organism begins to respond in the same way to different objects, and in different ways to the same object.

At the first level of detachment the individual interacts with elements that are present and do not induce a biological response, but that become relevant due to their conditionality relations with biological elements. Three types of interactions can be identified at this level:

a) In the most simple type the individual responds to relations between events, some of which do no produce biologically relevant responses. This way, the fixed and non variable relation is substituted by another linked to it, and which includes new elements. Many sensory and perceptive phenomena of the researcher are appropriate examples, like detecting the joint presence of two specific stimuli or distinguishing the position of an indicator in a machine (see Roca, 1990).

b) In the next type, the subject responds to a relationship between environmental elements designed by a former action of the individual. That is to say the subject organizes the relation among the elements of the environment to which he/she responds. Many motor activities where the researcher changes environmental situations with his/her manipulations are of this nature, e.g, when counting the frequency of a specific event, when operating an apparatus or when giving instructions to individual participating in research.

c) In the third type the relationship between the individual and some elements of the present environment depends on the changing situation of other elements of the environment or of the individual. The formerly described activities take place, though now they are directed by additional elements. For example, they may occur when a researcher learns to push the same key in his computer depending on the menu of the activated software, or when the way in which he writes his observations depends on the recording code chosen. Even though there are differences in complexity among these three types of interactions, they have one feature in common: they all are intrasituational relations, focusing on the present situation.

At a second general level, the individual is also capable of interacting with respect to absent conditions referred by himself or another individual through a conventional linguistic code. At this second level, references involve interactions with former or future specific situations located within other spatial-temporal coordinates, relating the researcher with them as if they were present; these are extra-situational interactions. Many behaviours from scientific work can be identified in this level. For example, defining a phenomenon depending on the necessary operations to produce it, reporting the study, informing about the research plan and design, considering analogies and differences between two situations that are not present, or setting forth a potential relation between variables to replicate a study.

The third and most complex level of detachment involves interaction with the conventional language reference itself and not with a specific situation linguistically referred. Even though it can be relevant in different specific situations, an interaction can take place with all these situations at the same time and with none of them in particular. Thus, interactions are trans-situational, and suggest the formulation of prescriptions or rules applicable to different contexts (Ryle, 1949). They occur, for instance, when prescribing general conditions to apply data designs and analysis, when critically assessing a theory depending on the data resulting from other studies, or in cases where the scientist is capable of setting forth and justifying general rules. This is why many of the activities considered as creative thought and problem-solving, occur at a trans-situational level.

At large, the taxonomy just outlined entails a similar way of referring to the diversity of psychological activities because it defines them all with a common criteria of detachment. It also adds up to a continuum of growing complexity, where each level is built upon the other levels, including them as part of a new organization. The levels successively involve: 1) operating with what is present and specific, 2) referring to what one does regarding the present and specific, and 3) describing a series of referents as a general valid rule for all. This is why any hypothesis probably presumes interactions of an extra or trans-situational level in so far as it refers to absent situations, whereas the empirical nature of other concepts or data would indicate their intra-situational level, where the relevant elements of the environment are present spatially as well as temporarily. Thus testing empirically a hypothesis would then involve relations between concepts at different levels of detachment, to determine whether the inferior one is included in the superior one.

The levels described also represent psychological situations of a different meaning. It is not the same to perform a scientific task at an intra-situational level, linked to the most obvious and specific characteristics of the situation, than to understand the latter as a materialization of a more general and trans-situational rule. Sometimes the first practice is better, as it occurs in situations where the researcher counts frequencies, observe specific events, and other activities where superior levels of detachment are not necessary. Superior levels are more adequate and even essential for tasks such as setting forth new research problems, developing the right hypotheses or disseminating the results of a study. Inferior levels are easier to reach, though they involve less versatility and less adaptation to changes in the situation. When a researcher learns a task only at inferior levels it may be difficult for him to carry out adaptations. This occurs, for example, when a researcher at these levels carries out a specific data analysis such as F test and uses it across all his experiments without adjusting it according to the data or other circumstances of the particular study. However, the activities carried out at superior levels of detachment require more conditions and practices; they imply a greater possibility to generalize situations, they can generate new working paths, increase creativity, and more. This is why they are identified more frequently in tasks of "extraordinary science" (Kuhn, 1970), when we must be detached from specific events and consider them from other perspectives and with different characteristics to the usual ones.

Levels of detachment do not correspond with the morphologies of interactions, whether motor, verbal or of any other nature. At the same time, morphologies do not identify levels. Thus, even though extra and transituational detachments require a verbal medium, not all verbal behaviour involves these levels. In general, interactions of certain level can take place with in different morphologies, and a morphology can be involved at different levels. For example, the interaction with a statistical data analysis software package can adopt a series of very similar morphologies in different subjects and occasions pushing the keys with several fingers and looking at the screen and keyboard consecutively. Even with this similar morphology, however, interactions may be involved from the intra-situational level, in which an apprentice work would be linked to a series of instructions of the handbook or menu, up to the trans-situational level in which there would be an expert who would consider the different situations as examples of different general rules.

In addition, the levels of detachment should not be confused with the achievement each interaction represents. Achievements are external criteria with respect to which interactions are related; interactions are identified as relations between the individual and the environment, though with respect to attaining an achievement. There are many achievements in the process of doing science; among some are: setting forth problems, testing hypothesis, structuring knowledge, measuring variables, data collection, representation and analysis, and drafting of reports. None of these, however, identify levels univocally, and the levels do not correspond univocally with the achievements each interaction involves. Some of the achievements of science can be attained at different levels as may occur with data analysis and setting forth new problems, which can be carried out from either a intra-situational, extrasituational or trans-situational level. Other achievements, in turn, may require an extra-situational or an trans-situational level, like it occurs when identifying a specific type of experimental design in a research report.

Achievements can be identified with criteria different to detachment. According to some reports (Moreno, 1988; in press; Moreno, Trigo, Martinez & Carmona, in press) the variety of achievements seems to correspond to at least two general types of relations: 1) assignment of cases or values of an event to another event, and 2) comparison between values of an event assigned to different values of another event. Thus, each achievement of science may be understood in terms of these two relations established by individuals. For example, problems and hypotheses of science involve assignments between two or more variables; control techniques such as constancy imply the assignment of values of the controlled variable to the independent variable; measurement of a fact according to a scale is defined as assignment (Campbell, 1920; Russell, 1937; Stevens, 1946; Michell, 1990), as well as the mathematical concepts of function, correspondence and application, and therefore all the concepts defined in such terms, as a random variable, probability, probability function, lineal regression, or the determinant of a matrix (DeGroot, 1986; Meyer, 1970; Rojo, 1986, Strang, 1980). At the same time, the comparison is identifiable in any covariation between two events, in basic arithmetic operations such as substraction and division, or in statistical contrasts, whichever the complexity is.

If these and other examples were confirmed, the categories indicated would simplify the variety of achievements identified in science. For example, all hypotheses tests would be understood as a succession of assignments and comparisons, given that each relationship or assignment between two events may be valid by comparing the values of events that covariate with each other. A similar succession might arise in the generation of new problems and solutions according to exploratory studies (e.g. Martinez, 1993). In these studies, the assignments selected are those whose elements covariate in the corresponding comparison. Thus, if the categories are valid it is conceivable that different methodological tasks, like the ones formerly described, would involve similarities in terms of the type of relationships achieved by the subjects. In this way, we could reduce the variety of methodological concepts, which could present some advantages for the structuring of any subject to be investigated.

*Context and History of previous interactions*

In the psychological field model outlined here, each interaction studied relates to other factors. In each unit of study certain elements of the environment and the subject become relevant contexts that depend on the history of interactions of each subject. Some elements of the context are selected as relevant due to certain episodes of the subject history of interactions. This conjunction between context and history makes more probable the occurrence of a specific interaction. For instance, the interaction of reading in a specific article the expression | A | as determinant of a matrix, would be more probable if the subject has had experience on matrical notations and on some elements of the context such as familiarity with the content of the cited paragraph. On the other hand, in another context and/or a different history of interactions, this same expression would have been read by the subject as the block of a matrix, an absolute value, or even as a graphic way of highlighting a symbol.

In the tasks involving methodology many elements belonging to context and history can be identified. For instance, the type of graph used, the scale chosen for data representation, and the variability and the number of data can operate as a context in the interactions involved in data analysis (Bayley, 1984; DeProspero & Cohen, 1979; Furlong & Wampold, 1982; Knapp, 1983; Parsonson & Baer, 1978), just like spatial configuration in the recording coding sheet, the way instructions are delivered, and the components of the procedure operate as such in data collection (Cronbach, 1971; Fagot & Hagan, 1988; Suen & Ary, 1989). Among the elements of the context provided by the researcher we can stress his/her visual sharpness, physical status or any other biological condition existing at the time he/she collects the data.

On the other hand, the history of interactions is sometimes referred to as the culture of origin, age, gender or character of the researcher (Horn & Haynes, 1981; Schultz, 1969; Simonton, 1984; Jung, 1982). These variables are often used to summarize or classify certain types of individual experiences. However, given their general nature, they are not always good summaries for distinguishing different histories of interaction. In the same way, individual history is referred to in other occasions as instruction, training, knowledge, or experiences the researcher has had in certain tasks (Brodgen, 1962; Kraut, 1978; Wampold & Furlong, 1981). The scientist's previous ideas make sense as histories of former interactions that make the current researcher's activities more probable; idea that has been defended broadly in psychology (Cronbach, 1980; Khaneman, Slovic & Tversky, 1982; Messick, 1981; Nisbett & Ross, 1980; Tweney, Doherty & Mynatt, 1981; Weimer, 1979) and in philosophy of science (Hanson, 1958; Kuhn, 1970; Wittgenstein,1953; 1982). The sets of former ideas of each scientist can be identified with methodological terms such as theories, models, hypotheses, and classifications. In fact, even though as a general principle these terms are usually considered as existing independently of individuals, in practice according to the scientists there are different versions and different uses of them and a whole variety is introduced due to the diversity of conditions of each individual.

History is also included in the formal concepts of science, but it is not usually identified. The specifications of the material to be analyzed, that accompanies any formal definition (such as the set of Mmx matrices of mxn order or the R set of real numbers), suggest a whole series of previous interactions consisting in certain operations with matrices and numbers. Because they involve histories of interactions and to shape two identical histories is difficult, the scientists' behaviour manner differ in those formal areas where homogeneity of actions is intended by means of these specifications. In fact, in practice not all scientists use the elements of a specific formal definition in the same way, nor do scientists always follow the same steps with the same elements. If individual history was not involved, there would be no mistakes when working in on these topics, nor would there be the innovations by some individuals with the same material that others use regularly.

## The psychological field as a descriptor: the meaning of each interaction

As we have illustrated, interactions and the types of factors that affect them can be identified within the scientist's activities described as method. We could identify the following factors in the methodological concepts:

a) Assignment and comparison *achievements* with respect to interactions between the individual and elements of his/her environment,

*b) levels of detachment* of each interaction involved and,

c) the influence *context* factors and individual *history* performance on the occurrence of each interaction.

Within the interbehavioral model outlined these factors are integrated in one unit as a psychological field. Only the combination of all these elements can contribute to relevant descriptions of the scientist's activities referred by concepts of method. Therefore, each one of these activities will correspond to a specific psychological field formed by one or more interactions at certain levels of detachment, identified with respect to some achievement in terms of assignment and/or comparison, and made probable by elements of a context and former interactions. Likewise, each psychological field represents a segment of the constant flow of the interrelation between the individual and the environment; that is why identifying a single field or sequence is equivalent to carrying out synchronic and diachronic descriptions respectively.

The descriptive possibilities of this model are broadened when the former interactions comply with another function. Previous interactions make probable the occurrence of a new interaction, and give meaning to each interaction included in it. In agreement with Wittgenstein (1953), the meaning of words and practices is given by their use or function, which means recognizing the importance of the linguistic, behavioral, and social frameworks in which each word and practice are raised. Each term acquires meaning only with respect to articulated systems of usage and practice, with relation to language games or individual ways of behaving with a social meaning. By forming systems with a global meaning, language games would have the capacity of giving meaning to each instance of particular activity. In this way, each instance would only acquire meaning in a specific language game.

Activities can be understood in terms of the individual/s interactions, and each language game would imply a specific set of interactions. Therefore, each interaction described acquires a meaning determined by their inclusion in a specific set of interactions that are part of the individual's history, all of which are part of a psychological field. This relation of inclusion is then equivalent to acquiring meaning on the behalf of an interaction. To this regard, identifying an interaction means recognizing it explicitly as a component of a specific set of practices, in the same way that interacting with meaning indicates agreement with the set, whether it is accompanied or not by the formerly mentioned recognition.

This inclusion has a necessary character, so that when we do not know in which set to locate a fact we do not understand its meaning. It also involves a relativist position with respect to knowledge. No concept or practice has an absolute meaning regardless of its relationship with a specific set. Everything that is considered as a fact or knowledge is seen as such inevitably "according to" or "in agreement with" a specific set. That is why the idea of scientists working with "pure facts" with their own knowledge regardless of all formerly acquired theories or knowledge has been abandoned (Hanson, 1958). We could then state that behaving conditioned by a specific history is also behaving according to a set of certain former interactions. Identifying a specific interaction within a set of interactions is a way of knowing its meaning. Along these lines we have a simple and useful tool to describe and interpret the meaning of the scientist's activities. Included in the subject-matters of study should be the sets of interactions relevant to the work of science, namely all those that provide meaning to each practice of the scientist.

Due to their significant role in the programme brought up we will elaborate more on these concepts. As yet, one could say that some sets of former interactions operate as *domains* providing meaning to each interaction included in them (Moreno, 1992). A domain is a set, and each set can be defined by extension or intension; in the first case it is defined by the enumeration of its components; -in the second by an outline or significant general aspect. But in both cases the domain only has meaning as something global or as a set of events. Therefore, the dimension of the concept of domain is not comparable to that of each interaction or event in particular. If this difference is not taken into account, we would be making what Ryle (1949) calls a categorial error, which would consist of treating a concept referring to something global or a set as if it was of a particular type. Making this mistake would be to reificate as a specific fact what as a set is an abstraction.

Considering the domains as a set of former interactions allows us to analyze them in the field of specific individuals, to deduce some characteristics, and to describe cases of scientific and methodological practice. Firstly, each domain is a subset of the total interactions experienced by an individual. The individual experience, which is in constant development, can be contemplated as a multiplicity of domains. Thus, on each occasion, only one or more of the subsets of the total set of previous interactions is relevant. Methodological notions like models, theories, hypotheses and research studies refer to domains of different sizes and complexities. The general nature of the concept of domain allows for a variety of sets relevant to the individual. For example, research is a domain that provides meaning to diverse tasks including the delimitation of variables, planning of designs, and data collection and analyses. But it should also be noted that each of these tasks constitute at the same time a domain for a series of activities, such as making appointments with subjects, giving them instructions, giving them materials, and collecting their personal data. At the same time all the tasks of a research can be understood in the broader domain of the researcher's professional tasks. In brief, identifiable domains are infinite and their delimitation is an issue of social convention.

Secondly, each domain involves a particular configuration of its elements. It implies a composition of activities, each one with certain varieties and possibilities, as well as different relationships among them. Rules and criteria prevail in each domain; without criteria it could be considered as something different to the configuration itself. To behave in agreement with the rules is to behave immersed in a specific domain, in agreement with a set of interactions. In this sense following rules, norms and methodological criteria that prevail in science is not different to operating in agreement with the set of practices and activities called science. Rules, norms and criteria do not exist regardless of these domain sets. In any case they are abstractions of the practical components of the domains. To behave according to the norms of science is to act in specific ways, which are socially considered as scientific. For example, to point out the criteria of observability for scientific concepts means to refer to the fact that in many scientific domains we include many and varied interactions carried out at an intra-situational level of detachment.

Thirdly, different possible relations among sets may take place between domains. For instance, some of the domains would result disjointed. This occurs often in methodology among those topics that do not have common elements, like the test of analyzed hypothesis with formal models and the search for new problems. A more common situation is intersection, where many domains have common elements. This is precisely why it is possible to move from one domain to another. For instance, an individual will consider the sign O as zero, a vocal or a small ellipse depending on the numerical, alphabetical, or geometrical domain in which he finds himself; in the same way, a scientist can consider numbers 3 and 8 different within the domain of natural numbers, but equivalent from the domain of probability in certain statistical contrasts. For research psychologists a specific activity of individuals studied can be considered in agreement with the theoretical domain used as an operant response, the consequence of a mental operation, or the expression of the unconscious. In each instance there is a location in different domains of what is considered the same element, so that is why it is transferred to different domains. It is then a path used in psychology of science to analyze, for example, the cases of perceptual restructuring or reorganization, changes in perspective, and cognitive reorientation and other similar domains that are relevant in creative aspects with respect to new hypotheses, innovative procedures, and changes in paradigms.

Fourthly, there are domains with clearly marked boundaries, in which practices that shape them or the defining characteristics are determined. This occurs in science within the linear regression model, when having many research designs or different types of numbers. In such domains it is logical to carry out certain operations and not others. It is obvious that the clearer the boundaries, the greater the probability of coinciding or reaching agreement with in those domains. This clarity is not a general rule, however. In fact, it is difficult to achieve because even though the elements that compose the domain are exhaustively fixed, they can have a different meaning for different individuals depending on other specific personal domains. There are then domains with non-specified limits to a greater or lesser extent, as there are non-identified domains for certain people at certain times. This occurs because a domain is a set of practices for individuals and not an aprioristic entity with existence regardless of such practices. A domain does not exists regardless of the set of interactions or practices. Moreover, describing a domain is to identify groups of practices. Because all establishment of boundaries is done by convention, stating that a domain has no clear limitations means that there is no agreement on whether changing an element implies changing the domain, which also may suggest that there is no agreement in the involved conventions.

The lack of specificity of limitations as well as of the location of the interaction in different domains can result in ambiguity in the work of scientists; in particular, in those cases where the domain to which the interaction belongs is not clear. Even so, when in these situations one can clarify the relevant domain, the contextual elements normally play an important role. To this regard, an element becomes an element of the context if it was present at the time the event was studied, but it does not constitute itself the subject matter under analysis. Within the field model approach, context refers to that elements which are not part of the interaction being studied but belong to the same domain set. Consequently if the context only belongs to one domain, it could be clearly identified.

In brief, these and other ideas derived from the concept of domain can be used to guide the study of different issues in scientific methodology. Considering the historical factor as a domain may add further relevance to the psychological study of science. Identifying interactions and their domains would allow us to study the relevant practices of scientists, which may be convenient for economic and heuristic reasons. As an illustration, the identifications of phenomena based on systems of categories and measurements based on scales were highlighted. These activities have been considered as different and have been approached as such in the literature (Bunge, 1983; Cliffs, 1982, Mook, 1982; Michell, 1990, Narens & Luce, 1986). These differences, however, are reduced when we consider that both category systems and scales imply domains, from which scientists assign meaning to the facts. Thus, defining and measuring could be viewed as activities with common criteria. In terms of similarity of interactions and domain involved, other differences could be reduced, such as differences between experimental and correlational research, data analysis and design, hypotheses testing and the achievement of new concepts, and others.

In conclusion, identifying interactions related to a specific context and domain is a basic task of the field model approach to the study of scientist's activities. It involves a psychological perspective where there is no place for presumed mental processes nor it is of a different nature of individual practices, being this practices elements of sets of interactions. The meaning of any subject matter under study should be searched for in these sets. Thus, classical psychological topics like memory, intelligence, and perception should be studied as interactions taken from different sets. For example, grouping different interactions according to their effectiveness in new and varied contexts might involve studying intelligence; on the other hand, grouping them according to their similarities with other interactions that are separated in time, might involve studying memory. Several authors have given examples on these topics (e.g. Ribes,1990; 1990a; Roca, 1990; Martinez, 1993), based on the ideas of philosophers such as Ryle (1949; 1979) and Wittgenstein (1953; 1982).

## The concept of validity from the psychological field model approach

As an example of our programme we will briefly discuss the issue of validity of concepts and activities of scientists. The traditional definition of validity involves a correspondence between what is studied and what is intended to be studied (Carmines & Zeller, 1979; Cook & Campbell, 1979; Martin & Bateson, 1986). In the field model, however, the correspondence that defines validity is among psychological fields. From this approach, validity refers to the correspondence between the researchers' activities and what he/she says the activities are, occurring both interactions in similar contexts and their historical conditions. This say-do correspondence can be studied, for example, between what is set forth as a hypothesis and what is observed in the corresponding research activities, between what is observed in the research activities and what is said in the final report, and between what is stated as done in the research report and what was really done.

The lack of validity of a particular concept would imply lack of correspondence between saying and doing. This may occur in at least two ways: First, due to the substitution of an element in the description of the activity to be carried out. For example, if numerical performance data are taken when the psychologist intends to study the verbal performance of elementary school students at a specific school, or if in effect the psychologist studies verbal performance but in a different school to the one intended. In other instances the lack of correspondence is more subtle. The problem lies in that what the researcher states he is doing has been modified. For example, studying the verbal performance in different grades of primary school without taking into account that there are different teachers in each grade. In such case "studying the performance of each grade" means in reality "studying the performance of each grade with different teachers". What is studied does not correspond to what was said to be studied, due to an unforeseen covariation among the field elements. This overlap can also take place in any other element of the psychological field: that is, between the interaction studied and a different one, or between the interaction studied and a context or historic factor affecting the interaction. These substitutions and overlap of elements are described in methodology as a lack of control for confounding variables, and they occur, in particular, in studies referring to empirical research. Nevertheless, we believe that these elements have a much more general scope and can be identified under other headings and methodological concepts which are not associated with the control of variables.

Substitutions and overlap sometimes occur in the definitions of interactions named as scientific variables, in which case these definitions can be ambiguous or incorrectly delimited. Instead, when they occur in the field of taxonomies or category systems, methodology qualifies them as lacking the property of exclusiveness (Anguera, 1991). In models of data analysis overlap is referred to as colinearity, consisting in a non-desired covariation between certain elements of the object of study (Pedhazur, 1982). Thus, terms such as lack of control, ambiguity, lack of exclusiveness and colinearity refer to the same situation described here between elements of the psychological field, but considered from different methodological domains.

Validity is related to the clarity in the delimitation of the involved field, and therefore, of the domains involved in it. Setting appropriate boundaries of a domain in a psychological field requires identifying all its elements; this is a necessary pre-requisite for validity. We think that a series of methodological suggestions, perhaps unrelated, refer to this issue. These suggestions involve: requiring designs that can identify the highest figure possible of confounding variables, requiring that category systems be as exhaustive as possible, and that the statistical model for the data analysis be complete, for which it is necessary to specify all relevant variables and to add the error term. The same demands exist in the formal boundaries of a domain in which the object under study is set forth, allowing recognition of the elements and relations that can and should be carried out to avoid errors of omission and substitution and to preclude overlap between elements (i.e. variables).

## Conclusions

In this paper, the foundations for a research programme on the psychology of science described by its method were considered. This programme attempts to approach extensively and systematically the following aspects:

1. The use of psychological field model elements as a category system to identify the activities of scientists described by methodological concepts.

2. The validation and improvement of the category system to assess its capacity to describe the proposed subject-matter. This should be done ensuring that the current formulation is clear, that the field elements exclude each other, and that everything to be described is covered.

3. Once the system of categories has been validated, to compile comprehensive and sounder information on the different scientific activities, in terms of achievements, detachment, contexts, histories and domains. By describing each scientific achievement, we would know if they involve a certain degree of detachment or if they could be carried out at different levels of interaction. The described interactions would have to be studied in terms of changes in context and history factors.

4. To test a correspondence between each methodological concept and the activities of the scientist. The accumulated identifications of scientific activities in terms of interactions and their domains could suggest similarities, clusters or groupings among methodological concepts. Thus the psychological field could

provide additional information on the validity of some methodological concepts.

5. To use a broad range of subjects, materials and methods to approach the general objectives proposed, including: a) scientists as well as non-scientists working subjects, due to the common nature of psychological processes; b) studying subjects activities in natural situations as well as other situations; c) studying subjects in natural conditions, but also manipulating those conditions; d) studying subjects through observation, surveys, and questionnaires; e) carrying out exploratory studies to collect as much and as varied data as possible while proving hypothesis already set forth by other researchers.

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