APPLICATION OF SOCIAL NETWORKS TO DELINEATE SCIENTIFIC AREAS AND DISCIPLINES

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Résumé

L'objectif de ce projet est d'explorer les techniques d'application de l'analyse de réseau pour délimiter les disciplines et domaines scientifiques. Les listes des titres des sujets sont considérées comme insuffisantes et pas suffisamment flexibles pour décrire les relations entre les différents disciplines scientifiques. L'usage de l'analyse des réseaux sociaux pour la récupération d'informations dans la base de données multidisciplinaires était prouvé comme étant très utile pour représenter l'interdisciplinarité existant entre les différents domaines de connaissance. Cette étude révèle que la méthode est valide et peut être un outil pour l'étude de ces disciplines scientifiques qui représente plus l'interdisciplinarité, comme le cas de psychologie. L'application des techniques de l'analyse des réseaux sociaux pour l'étude des domaines thématiques ne nous aide pas seulement à choisir les disciplines scientifiques qui sont plus en relation ou plus pertinents dans notre centre d'intérêt, mais aussi se montre très utile pour détecter les revues en relation avec notre centre d'intérêt ; et comme ils ne sont pas inclus dans notre discipline, pourraient ne pas être facilement remarqués ou ignorés parce que ils sont publiés dans des publications qui regroupent d'autres sujets thématiques. L'utilisation des indicateurs bibliométriques comme les axes principaux dans l'analyse de réseau est très adéquate pour l'identification des

différents positions des disciplines, pas seulement dans le réseau mais aussi dans les différents sous-thématiques qui permettent d'avoir une vision plus détaillée, pas seulement d'un domaine scientifique unique mais aussi de toutes les disciplines incluses.

Abstract

The objective of this project is to explore the application of analysis of social networks techniques to delineate scientific disciplines and areas. The lists of headings of the subjects are considered insufficient and not flexible enough to describe the relations between different scientific disciplines. The use of the analysis of social networks for the retrieval of information in multidisciplinary databases has been proved to be useful to represent the interdisciplinary existent among different knowledge areas. The study reveals that the method is valid and that it can be an effective tool for the study of those scientific disciplines that present a great interdisciplinary, such as psychology. The application of analysis of social networks techniques to the study of thematic areas, not only helps us to select those scientific disciplines that are related or the most pertinent inside our area of interest, but also proves to be very useful to detect those journals related with our area of interest; and since they are not included in our own discipline, could been easily be unnoticed or ignored since they are being published in publications gathering other thematic subjects. The use of bibliometric indicators as principal nodes attributes in the social networks is also very adequate for the identification of the different disciplines positions, not only in the network, but also in the different thematic subnets which allow us to have a much more detailed vision, not only of a single scientific area but also of all the disciplines included.

Resumen

El objetivo de este trabajo es explorar la aplicación de técnicas de análisis de redes sociales para la delimitación de áreas y disciplinas científicas. Las listas de encabezamientos de materias se consideran insuficientes y poco flexibles para describir las relaciones entre disciplinas científicas. La utilización del análisis de redes sociales para la recuperación de información en bases de datos multidisciplinares ha demostrado ser muy útil para representar la interdisciplinariedad existente entre áreas de conocimiento. El estudio pone de manifiesto que el método es válido y que puede ser una herramienta eficaz para el estudio de aquellas disciplinas científicas que presentan una gran interdisciplinariedad, como es el caso de la psicología. La aplicación de técnicas de análisis de redes al estudio de las áreas temáticas, no solamente nos ayuda a seleccionar aquellas otras disciplinas científicas que están muy relacionadas o las más pertinentes con nuestra área de interés, sino que también demuestra ser muy útil para detectar aquellas revistas relacionadas con nuestra área de interés y que al no estar incluidas en nuestra propia disciplina, fácilmente nos hubieran podido pasar desapercibidas por estar publicada en publicaciones recogidas en otras categorías temáticas. El uso de indicadores bibliométricos como atributos principales de los nodos en el análisis de redes también resulta muy adecuado para la identificación de posiciones de las diferentes disciplinas no solamente dentro de la red, sino también de las diferentes subredes temáticas lo que permite tener una visión más detallada no solamente de un área científica sino también de todas las disciplinas incluidas en la misma.

1 Introduction

Nowadays science is characterized each time more for being increasingly interdisciplinary. The greater complexity of research, with the consequently specialization of researchers, makes each time more necessary the collaboration among scientists from diverse disciplines to tackle problems and situations. This plural approach of researchers' problems is transferred to their publications which may seem associated to several subjects inside any classification. The subject classifications used in bibliographical databases and other documental sources are not universal and the combination of terms that describe satisfactory an area of interest does not coincide with the desired combination of other databases.

In multidisciplinary databases since their registers belong to different scientific specialities, these subject classifications are much more limited, and often are oriented to be used in a very excluding way in the phase of information retrieval. Nevertheless, this isolated, disperse and fractioned way of information research does not satisfy the multidimensional approach that science nowadays is supporting with their plurality of perspectives, which is the basis of research.

Nevertheless, interdisciplinary is not produced with the same intensity between the entire scientific disciplines configurating a network in which all their nodes are at the same distance between ones and others. It is produced instead much more intensely between some disciplines and it is practically absence in other sciences. Due to this reason, to set out and resolve a research problem it is necessary to know other disciplines with who a particular science is related.

In this work it is pretended to observe science as a skein of disciplines that are related between themselves with different intensity and gathered in different knowledge areas. The publications, as the results of the scientific research process, correspond to the same characteristics; this way a thematic classification from a bibliographical repertory has been used to represent the relations. Psychology is the area where we have tested our research since it is a scientific discipline that has different specialities.

In order to do so an application of analysis of networks to the thematic classification to Psychology journals is proposed, with the aim to identify the existent relation between the different specialities in psychology with other kindred scientific disciplines. Reinforcing this idea there is the fact that some databases from a same journal might be classified in several subjects simultaneously. The fact that a same journal is characterized by two subjects implies a link between these two subjects, a relation, a thematic proximity, an interdisciplinary knowledge field.

The analysis of social networks studies the relations that are established in a series of elements, that might be people, institutions, countries, or as in our case, subject classifications. While in traditional social analysis, the elements are studied classifying them or regrouping based of their characteristics: stratification of a population in different social classes, gender division, geographical origin, etc., the analysis of social networks is based in the idea that the structure or relations between elements explain better as a whole, the social environment and also each of its elements, than the attributes of these been united.

The objective of this work has been the application of the methodology of social networks to the identification of relations that are established between the different subject classifications where psychology journals have been classified; in databases such as Journal Citation Reports® (JCR), Social Sciences Edition (SSCI) and Science Citation Edition (SCI). These same relations represent at the same time the interdisciplinary that is given not only in Psychology,

but also with other scientific disciplines gathered in these information sources. This way, we can know the subject classifications nearer to the scientific discipline that is object of bibliographical research, which may help us to refine the bibliographical search process where any scientific research starts.

2 Material and methodology

The information sources consulted for this study have been: Journal Citation Reports®, Social Sciences Edition and Journal Citation Science Edition, from the Institute for Scientific Information de Philadelphia, now Thompson, founded by Eugene Garfield. This source has been chosen due to its multidisciplinary character and its widen coverage.

These two databases gather more than 8,000 international periodic publications with their entire and abbreviated title, ISSN, periodicity, language, country of publication and editor. Apart from this main use, they also allow ordering the journals based in some bibliometric indicators, impact factor, immediacy index, cited half-life, total number of cites recibed, and total number or articles published, which converts this in a fundamental tool to compare periodic publications.

Both JCR from SCI, and SSCI classify journals based on subject classifications that they elaborate. Journal Citation Reports®, Science Edition classifies the 5,928 total journals in a list of 171 subject classifications or disciplines. Journal Citation Reports®, Social Sciences Edition gathers 1,985 journals that classifies in 55 subject classifications. One same journal might be classified in several subjects simultaneously (figure 1). The fact that a same journal is characterized by two subjects implies a link between these two subjects, a thematic proximity, a interdisciplinary knowledge field. There is also the case that a same journal might be gathered in both data bases (JCR at SCI and JCR from SSCI).

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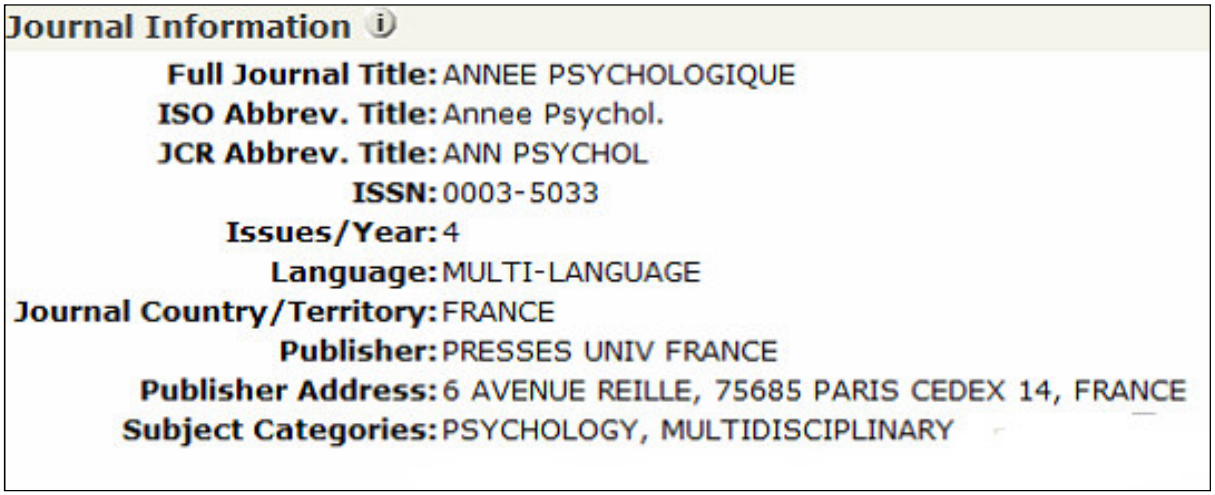

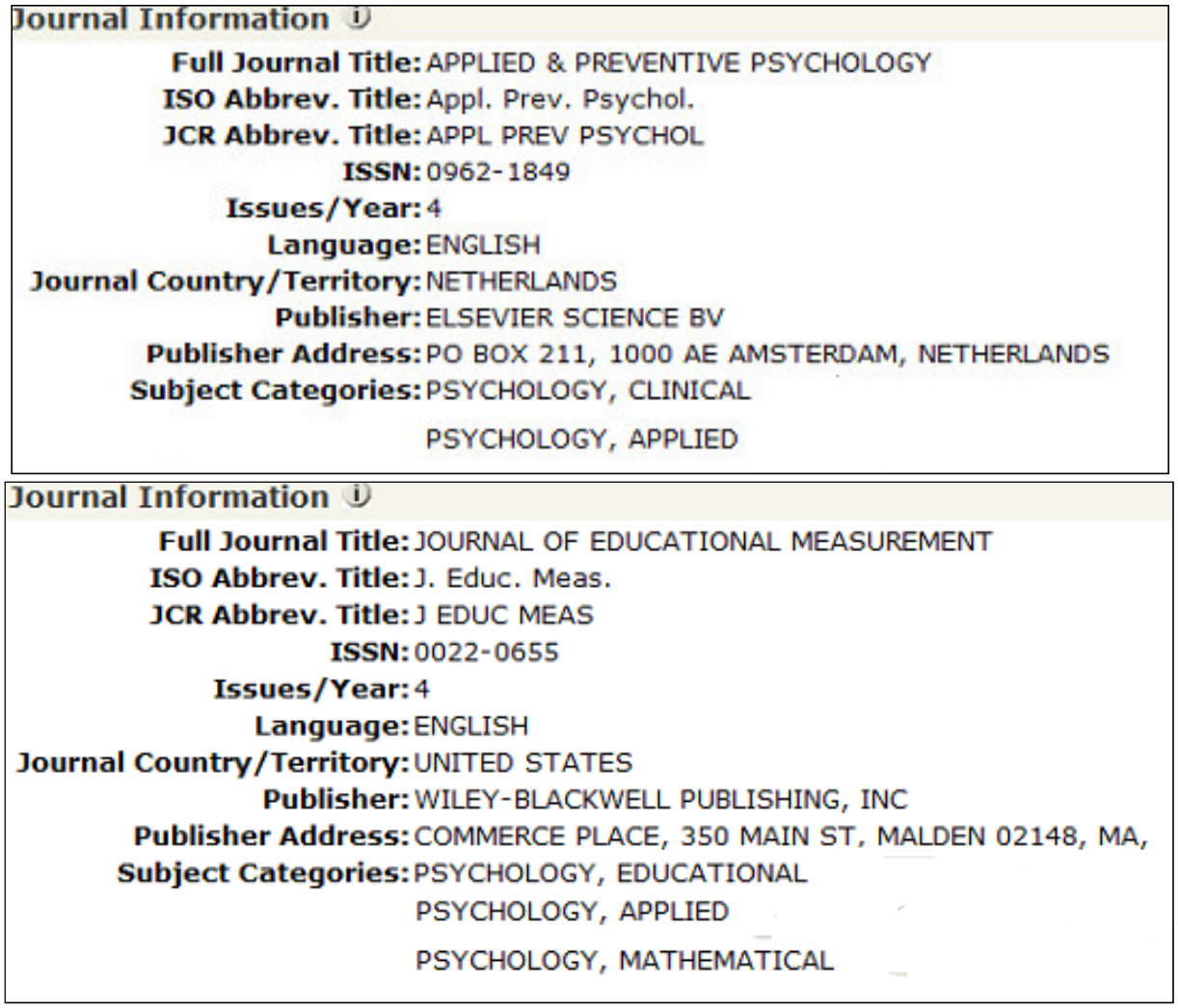

Figure 1: Examples of registers of a journal in JCR

The process that we have followed has been, using software of network analysis, create a chart that relates subject classifications with journals to convert it in a symmetrical weighted average matrix in which the actors are the subject classifications and the relationship that are established between them are the

simultaneous categorized journals in two or more subject classifications. The analysis of social networks has been done with the programme UCINET version 6 under license and representation of network graphic software Netdraw.

3 Results

Following the examples proposed in figure 1, it is observed that the Journal Applied & Preventive Psychology is classified in the subjects Psychology Clinical and Psychology Applied which implies that these two subjects are related among themselves. In the case of the journal Journal of Educational Measurement, we see it is classified in the subjects Psychology Educational, Psychology Applied and Psychology Mathematical, which also implies that these three are related among them.

The starting point of our project has been to create a matrix where all the subject classifications have been from the different psychology journals has been gathered, from the databases JCR (SCI and SSCI). The matrixes allow gathering the data of all these cases; still, when it deals with very extensive matrixes it is difficult to sense through their lecture any kind of relationship. With the graphics it is just the opposite, which converts them into the perfect complementary tools for a network analysis. The network graphs permit sense clearly the existent relations between the actors, but these can be incomprehensible if we download the whole information provided by extensive matrixes. The network graphs have two basic elements: dots and lines, which respectively represent the actors and their relationships. In this case, the dots are subject classifications of psychology journals and the lines the relationships that they establish.

Figure 2 represents a network formed with the totally of the subject classifications that have been classified in psychology journals gathered by two data bases used in our project (JCR at SCI and JCR from SSCI). When observing the graph the first thing that catches our attention is that all the subject classifications form part of a unique component, no subject is totally unconnected from the rest which indicates a high degree of interdisciplinary environment.

A *component* is the major sub-joint of possible nodes and its links in which all the nodes that integrate it are connected at least to another node from the sub-joint and from which it is possible to reach from and to any other node from the component, by following the links that it contains (Rodríguez, 2005). The size of the nodes represents the volume of journals that have been classified under this subject classification. When we study the internal structure of the components it is important to observe the different qualities of some nodes among others. The subjects that weight more, this is, the ones that are accumulated in a greater number of journals in the databases are: Psychology Multidisciplinary, Psychology Clinical, Psychology Experimental and Psychology Applied. However, there are subjects that have a great prominence, since they have a “brigde” role inside the network. This means that there are several subjects that if they were to be eliminated from the network, they would convert in a unique component connected into several disconnected components. These nodes with greater capacity of intermediation are from the subject classifications: Psychology, Psychology Experimental, Psychology Applied, Psychology Multidisciplinary and Psychology Social. This indicated that they are very interdisciplinary subjects and that also work as a bridge between other subjects with which they are connected.

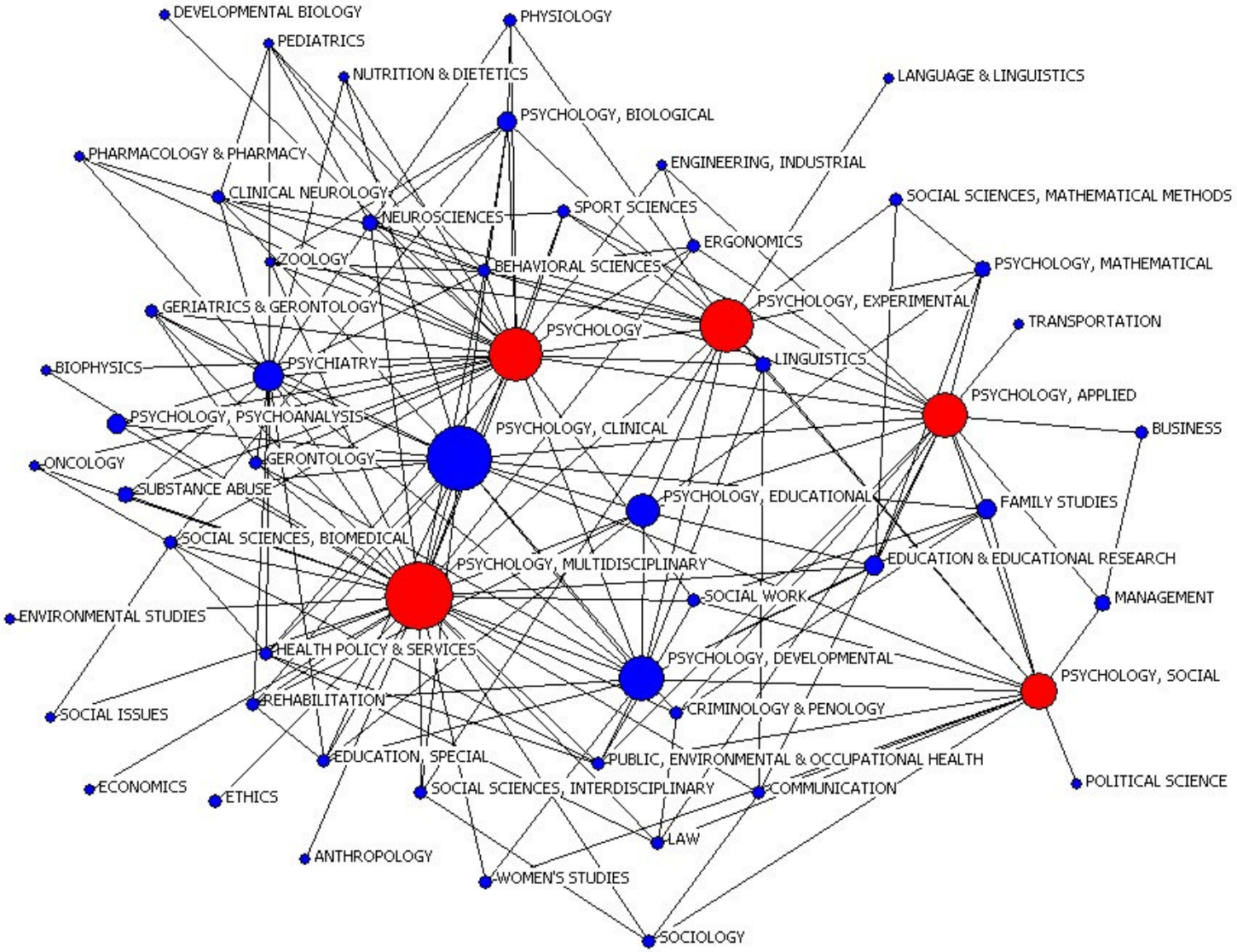

Figure 2: Subject classification Networks from Psychology journals (SCI and SSCI)

If we eliminate the network that represents the total of the subject classifications from Psychology journals (see figure 3), it is observed that there are isolated nodes, this means, that they are not united to any other element by means of links, and that they represent elements that do not interact with the rest of social elements surrounding them, as it happens with these thematic areas: Anthropology, Biophysics, Developmental Biology, Economics, Environmental Studies, Ethics, Language & Linguistics, Political Science, Transportation and Women's Studies.

As we have mentioned before, we can apply the analysis of networks to study specific interdisciplinary thematic areas and, to know the relationships with the rest of disciplines or subject classifications. The networks exposed in figures 4, 5 and 6 are the graphic representation of the relations matrix of three of the subject classifications where are included psychology journals in JCR's databases. The subjects that have been selected to represent are: Psychology Experimental, Psychology Multidisciplinary and Psychology Social. In all the sub-nets, the size of the nodes represents the volume of journals contained in the subject classifications and the thickness of the link that unites nodes between themselves, are given by the number of journals that share both subjects.

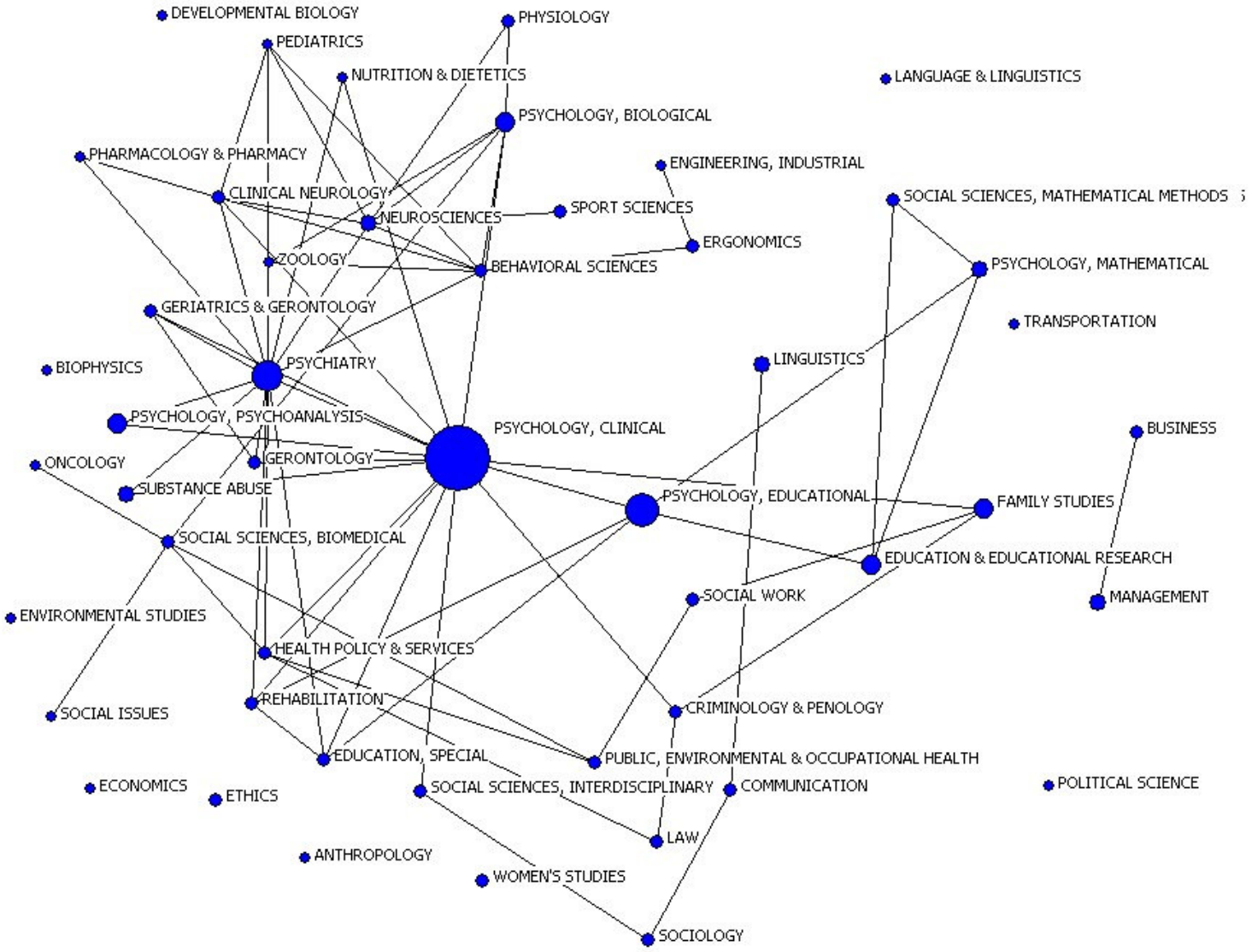

Figure 3: Phychology's thematic network without representation of "brigde" nodes

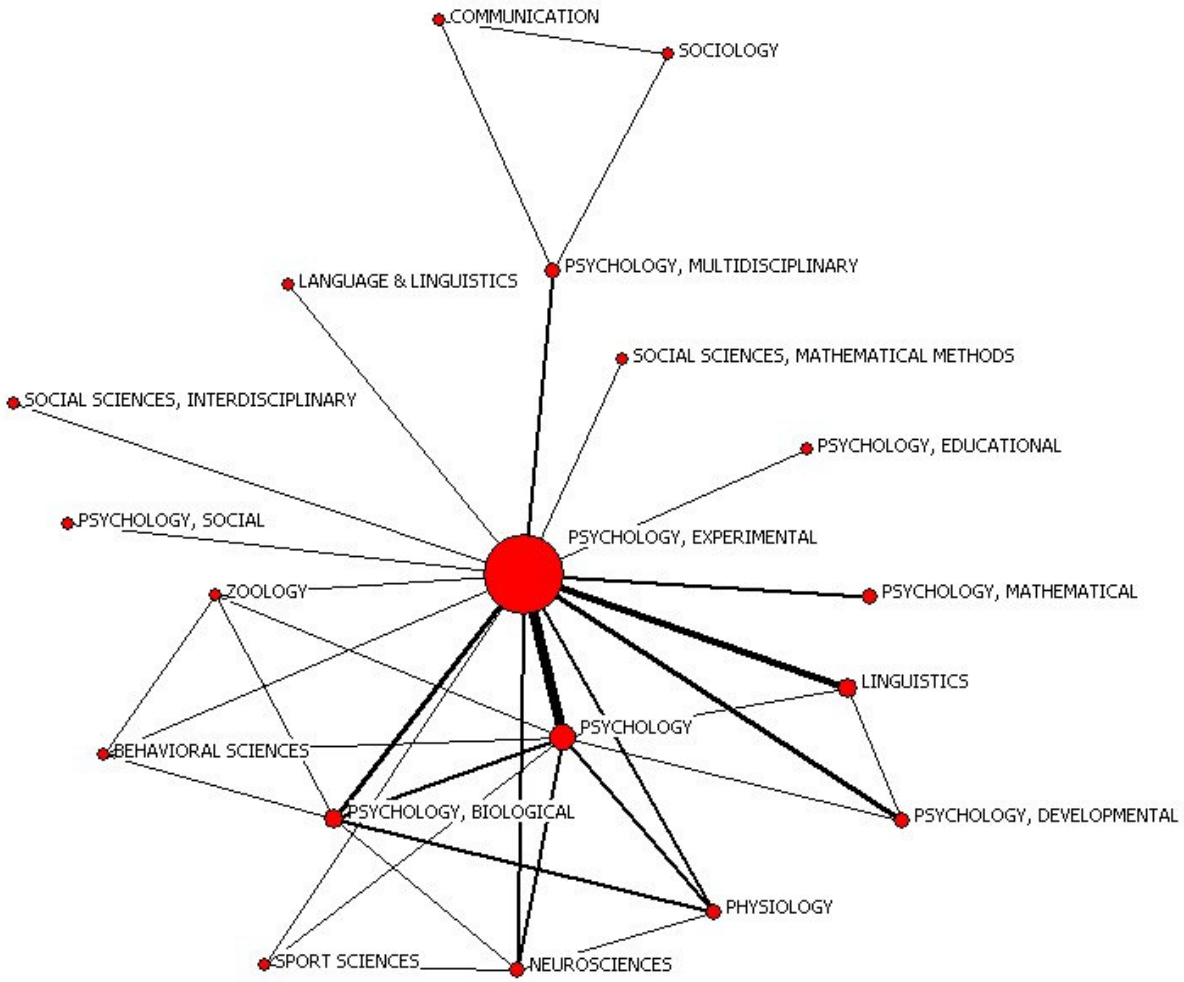

Figure 4: Subnet of the thematic subject Psychology, Experimental

Figure 5: Subnet of the thematic subject Psychology Social

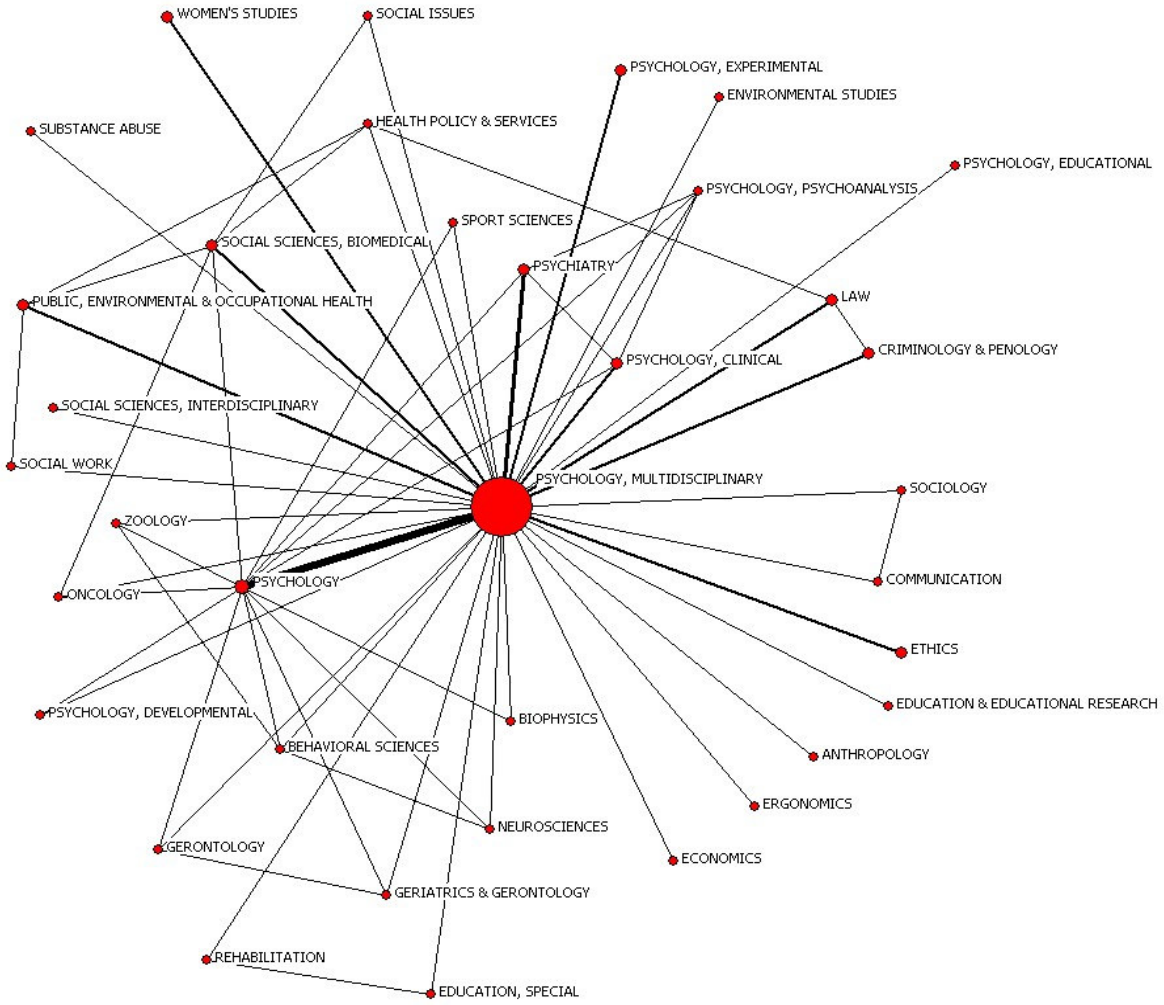

Figure 6: Subnet of the thematic subject Psychology, Multidisciplinary

4 Conclusions

The analysis of Networks ends up been very useful and adequate to identify the existent relationships between the subjects from the subject classification of Journal Citation Reports®, Social Sciences Edition (JCR) and it helps also to objectify the interdisciplinary that is given among the scientific disciplines gathered in the mentioned source of information.

A research strategy to select scientific works belonging to a subject classification that takes into account the relations of this work shows will escape to the stiffness of the selection of a group of subjects pre-conceived that never explains correctly the overlaps among them and that runs the risk of mutilate extensions of some of them by simply producing silent among the most incipient and recent relations.

What is presented in the databases as a plain list of subject classifications it is really a very dense network of different disciplines relationships. The connexion between them is given by other subject connected by means of other subjects.

The strategic importance of a determined subject can not be assessed exclusively by its size, number of articles accumulated. For its range, this is, the amount of relationships that it maintains, its intermediation, this is, its capacity to permit the connexion of other subjects between themselves, its closeness, this is, their possibilities to connect quickly with other nodes are also very important and this is especially given in the youngest subjects inside a particular thematic area.

Knowing the closest disciplines to a scientific discipline in which a determined research problem is framed, may help to a multidimensional conception of the own interdisciplinary problem. The networks graphs presented specify the plurality of perspectives from which a scientific research may be dealed. The application of the analysis of networks to the representation of thematic areas used to classify the scientific journals in the different data bases, may be used as a tool of support for the localization of journals and works that might be very closely related to the object or themes of study.

Acknowledgement

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5 Bibliography

[1] BORGATTI, S.P and MOLINA, J.L. *Toward Ethical Guidelines for Network Research in Organizations.* Social Networks. 2005, vol. 27, 2, p 107-117.

[2] LOPEZ, M.; VELASCO, E. y OSCA-LLUCH, J. Grupos de, J. *La investigación españoles en economía y gestión: una aproximación desde el análisis de redes sociales.* Cuadernos de Inteligencia Competitiva, Vigilancia Estratégica, Científica y Tecnológica (Quick&Vect) 2009, 2 (1): Abril.

[3] MOLINA, J.L. *La ciencia de las redes*. Apuntes de Ciencia y Tecnología. 2004, 11, p.36-42.

[4] MOLINA, J.L. *El análisis de redes sociales. Una introducción*. Barcelona: Edicions Bellaterra, 2001.

[5] OSCA-LLUCH, J. *Some considerations on the use of the impact factor of scientific journals as a tool to evaluate research in psychology*. Scientometrics 2005; 65 (2), p 189-197

[6] OSCA-LLUCH, J., VELASCO, E., LOPEZ, M.and HABA, J. *Co-authorship and citation networks in Spanish history of science research.* Scientometrics 2009; 80 (2), p 375-385.

7] REQUENA SANTOS, F. *El concepto de red social.* Revista Española de Investigaciones Sociológicas. 1989, núm. 48, p 137-152.

[8] REQUENA SANTOS, F. *Análisis de redes sociales: orígenes, teorías y aplicaciones*. Madrid: Centro de Investigaciones Sociológicas, 2003.

[9] RODRÍGUEZ, J.A. *Análisis estructural y de redes*. Madrid: Centro de Investigaciones Sociológicas, 2005.

[10] VARGAS QUESADA, B. and MOYA ANEGÓN, F. de. *Visualizing the Structure of Science*. New York: Springer, 2007.