Retos
Revista de Ciencias de Administración y Economía

UNIVERSIDAD POLITÉCNICA SALESIANA ECUADOR

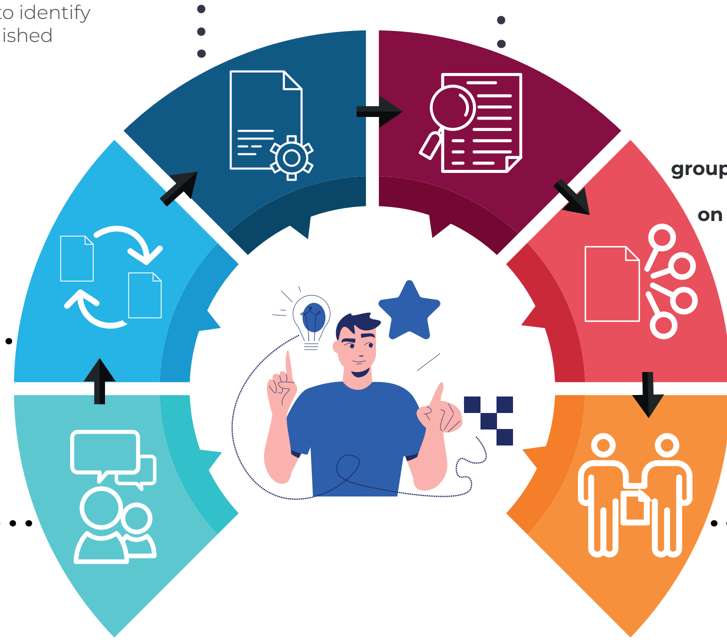
Behavioral and psychological game theory: a systematic review

Methodology

A systematic review was carried out using the PRISMA methodology, collecting papers that presented psychological variables, were peer-reviewed and had an experimental design to identify all empirical studies published under both names.

Objective

This research clarifies whether two of these theories, behavioral game theory and psychological game theory are the same.



Introduction

Game theory has been widely used in economics. It has contributed to demonstrate that people do not only decide based on rational criteria, but that there are psychological variables that affect our decisions.

Result or conclusion 1

The largest number of articles were published under behavioral game theory.

Results or conclusion 2

Most of the articles were grouped according to Camerer's (2010) classification based on the following four themes: social preferences, cognitive hierarchy, quantitative response, and learning.

Result or conclusion 3

Both theories were presented under different names according to the origin of their main authors: economic (Camerer) or psychological (Geanakoplos, Battigalli and Balafoutas)

Art. 7
Vol. 12 Núm. 24

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October 2022-April 2023
pp. 296-315
https://doi.org/10.17163/ret.n24.2022.07

Behavioral and psychological game theory: a systematic review

Teoría de juegos conductual y psicológica: una revisión sistemática

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Received on: 25/06/22 **Revised on:** 25/07/22 **Approved on:** 02/08/22 **Published on:** 01/10/22

Abstract: because of the game theory there is a better understanding of human behavior in the economy. However, since this theory excludes the psychological aspect from conduct, a revision of the rationality assumption completes the missed information in some games. As a consequence, some approaches have emerged including behavioral and psychological aspects in games, generating a large amount of literature distributed in apparently independent lines of research, a fact that could cause confusion. To clarify whether behavioral game theory and psychological game theory are independent approaches, a systematic review was conducted using the PRISMA guidelines to identify all empirical studies published under both names. Papers that (1) had psychological variables, (2) were peer-reviewed, and (3) had any experimental design were collected. From 492 papers searched, 67 were included in this systematic review. They were organized and studied to determine what type of psychological variables they included and whether there are really two different approaches. The most common term used is behavioral game theory in which variables like guilt, trust, motivation, and reciprocity are widely used. The main conclusion is that the two approaches are really the same and it is the followers of the main authors of each current who publish under one or the other name.

Keywords: behavioral game theory, psychological game theory, behavioral economics, game theory, decision making, decision theory, social behavior, cognitive hierarchy.

Suggested citation: López, R., Calvo, J. L. and de la Torre, I. (2022). Behavioral and psychological game theory: a systematic review. *Retos Revista de Ciencias de la Administración y Economía, 12*(24), pp. 296-315. https://doi.org/10.17163/ret.n24.2022.07

Resumen: gracias a la teoría de los juegos tenemos una mejor comprensión del comportamiento humano en la economía. Sin embargo, como esta teoría excluye el aspecto psicológico de la conducta, una revisión del supuesto de racionalidad completa la información perdida en algunos juegos. Como consecuencia, han surgido algunos enfoques que incluyen aspectos conductuales y psicológicos en los juegos. Esto ha generado una gran cantidad de literatura distribuida en líneas de investigación aparentemente independientes, hecho que puede generar confusión. Para aclarar si la teoría de juegos conductual y psicológica son enfoques independientes, se realizó una revisión sistemática utilizando las directrices PRISMA para identificar todos los estudios empíricos publicados bajo ambas denominaciones. Se recogieron trabajos que (1) tuvieran variables psicológicas, (2) estuvieran revisados por pares y (3) tuvieran algún diseño experimental. De los 492 trabajos buscados, 67 se incluyeron en esta revisión sistemática. Se organizaron y estudiaron para determinar qué tipo de variables psicológicas incluían y si realmente existen dos enfoques diferentes o no. El término más utilizado es la teoría del juego conductual, en la que se utilizan ampliamente variables como la culpa, la confianza, la motivación y la reciprocidad. La principal conclusión es que los dos enfoques son realmente el mismo y son los seguidores de los principales autores de cada corriente los que publican bajo uno u otro nombre.

Palabras clave: teoría de juegos conductual, teoría de juegos psicológica, economía conductual, teoría de juegos, toma de decisiones, teoría de la decisión, comportamiento social, jerarquía cognitiva.

Introduction

Game theory is the process of decision making in uncertain situations and arises in economic thought. It was introduced by von Neumann and Morgenstern (1930) under the name Game Theory and Economic Behavior. Game theory was based on the assumption that rational individuals create strategies to maximize their own welfare, while considering the accurate beliefs of others' decisions. Likewise, behavioral game theory goes beyond classical game theory to explain bounded rationality problems (Camerer and Ho, 2015) and expectations about players' behavior, fundamental variables in the field of economy (Mejía *et al*., 2019) and even in the formation of culture (Geizzelez-Luzardo and Soto-Gómez, 2021). Some examples of games could be the prisoner's dilemma or the ultimatum game. The prisoner's dilemma game (Poundstone, 1992) involves two prisoners who have to choose separately to testify against each other or to remain silent. If one betrays the other, both serve two years in prison. If both remain silent, they serve only one year in prison. If one of them betrays the other and the other remains silent, the former will be released, but the latter will serve three years in prison. The ultimatum game (Güth *et al*., 1982) is an experimental economics game in which two parties interact with each other anonymously only once so that reciprocity is not an issue. The first player advocates splitting a sum of money with the other player. However, if the second player rejects this division, neither player receives anything. These games, as well as many others, demonstrate the importance of variables such as trust, fairness, or collaboration beyond the goal of maximizing utility. For example, in the prisoner's dilemma it is common that players make a decision that harms them in the face of distrust.

Although different terms have been used to refer to the introduction of psychological variables in games, behavioral game theory and psychological game theory may be the most complete, integrative and commonly accepted. In fact, as will be presented in the conclusions, both terms refer to the same phenomenon. The term behavioral game theory is more commonly used by authors from the field of behavioral economics and the term psychological game theory by authors from the field of economic psychology.

Therefore, this is a systematic review that synthesizes most of the published studies on behavioral game theory and psychological game theory. The PRISMA 2009 guidelines (Liberati *et al*., 2009) are used to delve into the papers that use these novel variables. The papers have been divided into two classifications: one that is based on the review on behavioral games by Camerer and Ho (2015), and another based on labels that could adequately describe the psychological variables that influence decision making in each paper. These labels are considered the focus of each research, which parallel to Camerer and Ho's (2015) classification, facilitate the reader's understanding in terms of behavioral game theory. In addition, the characteristics of

Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

the experimental design, including sample size, experimental sessions, or whether the investigations were fully empirical or had a theoretical model accompanied by an empirical test, have been collected.

Based on the above, the following research question can be formulated: what psychological variables have been included in the framework of behavioral game theory and psychological game theory? To answer this question, the systematic review is presented below, first introducing the historical background of how behavioral game theory could have emerged from an information problem in classical game theory. PRISMA 2009 method is explained for the systemic review and an in-depth analysis of the results is conducted, according to the aforementioned classifications and other empirical features.

The theoretical assumption of rationality in games arises from the player's knowledge of all the alternatives in the game, his/her evaluation and his/her choice of the most efficient decision for the situation. Based on this information, the player creates strategies, beliefs, and establishes trade-offs about what he or she values most. Games rarely provide complete or accurate information; therefore, not only will some errors occur, but assumptions about rationality may also begin to fail (Simon, 1990).

The first author to refer to asymmetric information was Harsanyi (1967), who created a new model of games in which players must consider probabilities in their strategies because they ignore the actions of others. This point of non-information has more relevance when classical games are the subject of experiments, as in the work of Mäs and Nax (2016), in which coordination games present uncertain noise related to human behavior. A non-experimental example studied by Radner (1980), showed how in a Cournot-type model, agents play responses close to the best strategies of others, rather than playing accurate and best responses. Furthermore, McFadden (1976) have shown how errors in beliefs and strategies can occur, making this inaccuracy much more significant. Modeling these errors as probabilities in players' own and others' actions was first stated by McKelvey and Palfrey (1995), who proposed a quantal response model that describes errors´ distribution as a density function (usually a logit function), leading to an important number of publications that focused on errors in driving strategies. Recently, several authors have made revisions and variations (Benndorf *et al.*, 2017; Goeree and Holt, 2004; Weizsäcker, 2003).

However, why do these errors occur? This is what game theory tries to answer because lack of information causes changes in behavior. Selten (1978) and Kreps and Wilson (1982) observed through experiments some inconsistencies between game-theoretic reasoning and human behavior, and found that each agent had different interpretation levels of the game and of information from other agents. Some levels considered strategies closer to game-theoretic play, i.e., levels at which the agent approached rationality. In contrast, an experimental study of the centipede game by McKelvey and Palfrey (1995) observed how the subjective interpretation of other agents' altruistic behavior influenced the strategy implemented, called by Simon as bounded (1990). If agents are not fully rational in gathering the correct information, they tend not to play a strategy that maximizes their theoretical utility. This line of thought led to the introduction of a new branch of research.

This bounded rationality approach was established and generalized by Camerer *et al*. (2004) in a cognitive hierarchy model, which is a mental model based on the understanding levels of the game that each player has about the other. For example, level 0 players assume that all players are level 0 and design their strategies accordingly, but level 1 players, who understand the game better, know which players are level 0 or level 1 and play accordingly. These tiered mental models attempt to explain a player's guesses about the decisions and beliefs of others, according to his or her own knowledge of the game. When these decisions and beliefs come from higher cognitive ability and character skills, better strategic positions are more frequent (Cunha *et al*., 2010; Lindqvist and Vestman, 2011), because if there is more intelligence, there is also more ability to take information from the game and from other agents. Similarly, the more emotional intelligence, the more rational clarity there will be (Gill and Prowse, 2016; Heckman and Kautz, 2012). Moreover, as cognitive skills can lead to strategic advantages, this strategic intelligence can anticipate competitors' behavior (Levine *et al.*, 2017) with less impulsivity (Cueva *et al.*, 2016). Also, this game theory literature included research on archetypal personality games as in the Proto *et al.* (2019) experiment using games with individuals who have not yet fully developed their personality, such as adolescents and children (Sutter *et al.*, 2019), or games with individuals who have high psychoticism (Martin, 2017).

However, the fact that players have bounded rationality does not mean that they cannot predict the future behavior of other agents in dynamic games. Even if predictions are not accurate due to the presence of non-rational agents, they can approximate a rational equilibrium. The adjustments that players do regarding their prediction of others' strategies in games are called learning. Learning in games is well described in classical game theory, where agents reinforce the way they take in game information as the game unfolds (for a discussion, see Nachbar, 2020). However, because people have different cognitive abilities that produce some errors in strategy formation, learning, as a cognitive feature, also contains some errors (Eyster, 2019). Considering that quantal response models treat errors in strategy formation as a density function as the game elapses, these errors are modeled as probability distributions at each instant of time, hence, it is a stochastic model (e.g., Bravo and Mertikopoulos, 2017). Errors influence the prediction of other players' moves. This prediction plus the tendency to choose fruitful strategies from the past is what Camerer and Ho (1999) called experience-weighted attraction (EWA). EWA focuses on the predisposition of players to follow some strategies, expressed through a probability of choosing them again. When these probabilities depend on learning from others, it is called sophistication. Sophistication comes from the union between learning models and cognitive models. This is what Camerer *et al.* (2002) implemented with the k-level and EWA models as a way to explain sophistication and later refined with autotuning (Ho *et al.*, 2007). In addition to expertise, cognitive ability also influences the attractiveness of some strategies (Fehr and Huck, 2016; Gill and Prowse, 2016) and, of course, strategic sophistication (Penczynski, 2016).

Considering the evidence from reports in behavioral game theory, there is a better understanding of human behavior in games that can be useful in economic and commercial settings. Because classical game theory excludes the psychological aspect of behavior, these new approaches to the rationality assumption fill in the missing information in some games, making more accurate predictions about human behavior. For all these reasons, it is interesting to review the psychological variables analyzed from behavioral game theory and psychological game theory.

Criteria for selecting the corpus

A systematic search was conducted to identify publications categorized within behavioral game theory and psychological game theory that incorporated empirical research in decision making. The study followed the recommended reporting elements for systematic reviews and meta-analyses (PRISMA 2009) guidelines (Liberati *et al.*, 2009) in the systematic search. The databases included in the search were EBSCO (EBS), ScienceDirect (SD), Scopus (SC), Web of Science (WOS), and ProQuest-ABI/INFORM (PRO). The first four databases were selected in a multidisciplinary way to ensure that articles from both the economic and psychological fields were found. However, this study is framed within the study of behavioral economics, so the last database was selected to guarantee the presence of all relevant articles in this field. EBS is a multidisciplinary database, one of the main resources of specialized bibliographic information (Funes Neira, 2015). SD was launched in 1999 as a web-based database of Elsevier's periodicals and has grown to become the world's leading provider of scientific information (Alvite and Rodriguez, 2004). SC is a multidisciplinary bibliographic database of abstracts and citations of scientific journal articles; it is provided by Elsevier and is updated daily. WOS is a multidisciplinary bibliographic database whose indexes are formed by mainstream

Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

publications, being one of the main research tools in the academic world. PRO is a Business and Management database; its provider is ProQuest (Funes Neira, 2015).

The search was conducted using *behavioral game theory* and *psychological game theory* as keywords, using Boolean OR to search on title, abstract and keywords. In addition, the search was limited to peer-reviewed articles written in English. Once the initial results of the search queries were inspected, the references of the included studies were also examined and incorporated into the review if they met the inclusion criteria. After the initial search and reference review were completed, manual searches were performed for each of the journals identified in the search using the same keywords. This was done to determine whether studies not included in the databases were suitable for inclusion in the review. After several discussions regarding inclusion criteria, disagreements were resolved according to PRISMA 2009 guidelines. The initial search was performed on September 20, 2020, and the results for articles included in the EBS, SD, SC, WOS, and PRO databases were: 31, 60, 155, 70, and 135, respectively. Full-text versions of all selected studies were retrieved and analyzed by the first author to determine whether they met the inclusion criteria. In addition, the full search procedures were repeated by the second and third authors to ensure that the search results were reliably and objectively obtained and reviewed.

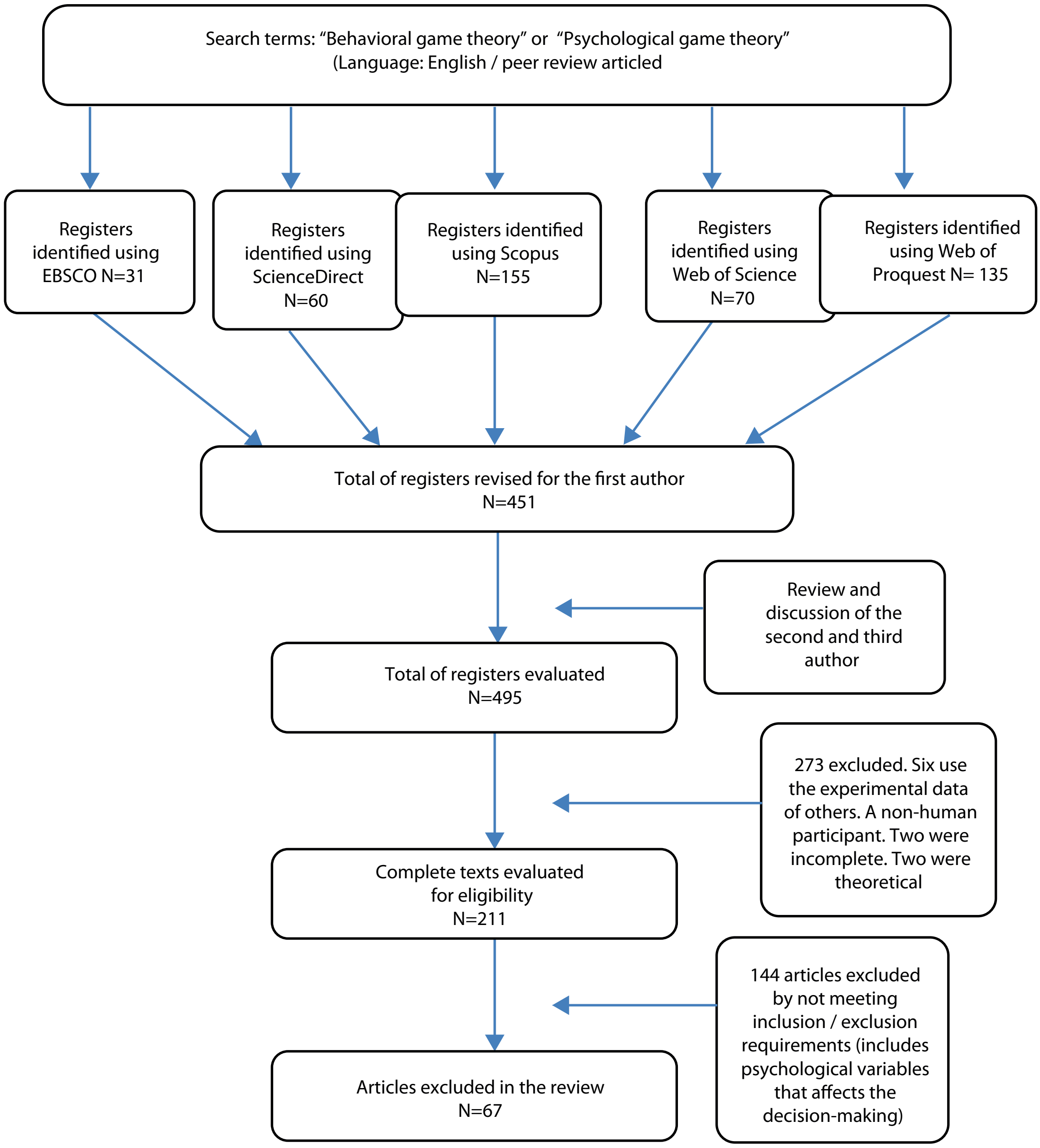
From all these articles, were selected those that (1) included a methodology showing the effect of any psychological variable on decision making, (2) were written in English, and (3) were published in a peer-reviewed journal. This resulted in 67 studies included in the systematic review. A schematic view of the article selection process is presented in Figure 1.

In the end, 67 articles met all inclusion criteria. The initial search yielded a large number of publications (n=492) of which 57.7 % were excluded because they were duplicated in the set or otherwise unacceptable. Also, 69.23 % (n=144) of the resulting 208 papers were excluded because they did not include psychological variables in the games. Partially experimental results were those that had a theoretical background constructed by the authors, while some used theories from other authors. Because the earlier papers had experiments to support the theory, we included them along with the fully experimental ones. Partial experimental papers accounted for 37.31 % of the total papers, and fully experimental papers accounted for 62. 69%.

One of the most interesting aspects of using the PRISMA 2009 methodology is the control of bias. It is necessary to assess the risk of bias at the study or outcome level. The degree to which a review can yield reliable conclusions about the effects of an intervention depends on the validity of the data and the results of the studies included in the review. Thus, for example, a meta-analysis of studies with low internal validity will produce erroneous results. Therefore, assessment of the validity of the included studies is an essential component of a review and should be considered in the analyses, interpretation, and conclusions of the review. Because this study is limited to a theoretical review and does not proceed to a meta-analytic study, control of bias is limited to ensuring that there are no missing studies. To control this bias, the second and third authors repeated the entire search, which was useful, because after the second and third author's review, we went from selecting 451 to selecting 495, i.e., 44 more articles were included. This is because the first inclusion criterion, which was to include a methodology that showed the effect of some psychological variable on decision making, was not clear in the studies that built a theoretical model that was then contrasted by supporting experiments.

Figure 1

Process for selecting the articles



State of the art

If reviewing the state of the art, we can group the different articles analyzed considering different criteria. If observing the methodological criteria, it can be observed that out of the 67 papers that were finally selected for the analysis, the only one that did not clearly present the total sample size was McCabe *et al.* (2003). However, it was observed that the samples used varied greatly among the articles, as shown in Table 1.

Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

Table 1
Design of the papers

Article	Experimental	Size of the sample	Sesions	Citations
Regner (2014)	Partially	31 120	-	6
Kearns *et al.* (2009)	Completely	2916	81	78
Sah and Read (2020)	Completely	2733	-	0
Johnson and Rips (2015)	Completely	1521	-	12
Franzen and Pointner (2013)	Completely	509	-	73
Macro and Weesie (2016)	Partially	453	22	3
Charness and Dufwenberg (2006)	Partially	450	15	807
Cardella (2016)	Partially	444	22	3
Ho and Weigelt (2005)	Partially	386	13	34
Bracht and Regner (2013)	Completely	384	12	18
Fugger *et al.* (2016)	Partially	372	-	22
Attanasi *et al.* (2019)	Partially	369	19	4
Sacconi *et al.* (2011)	Completamente	366	10	0
Wu (2018)	Partially	363	12	1
Póvoa *et al.* (2020)	Completely	336	12	0
Halevy and Phillips (2015)	Completely	320	40	43
Song (2009)	Completely	312	-	38
Berger *et al.* (2016)	Partially	305	4	3
Ackermann *et al.* (2016)	Completely	296	-	29
Giaccherini and Ponti (2018)	Completely	288	12	1
Bellemare *et al.* (2018)	Completely	284	12	11
Peeters and Vorsatz (2018)	Partially	278	-	0
Chen and Houser (2019)	Partially	273	17	1
Mäs and Nax (2016)	Completely	260	13	36
Laing and Morrison (1974)	Partially	256	41	18
Dufwenberg *et al.* (2011)	Partially	255	15	190
Tarrant *et al.* (2008)	Completely	243	-	0
Morell (2019)	Completely	240	15	0
Moinas and Pouget (2013)	Partially	234	12	28
Lindsay (2019)	Partially	208	10	1
He and Wu (2020)	Completamente	208	9	2
Rauhut (2015)	Partially	200	10	2
Bernasconi and Galizzi (2010)	Completely	192	17	2

Article	Experimental	Size of the sample	Sesions	Citations
McCubbins and Turner (2014)	Completely	190	-	1
Jin (2020)	Partially	184	6	2
Woon (2018)	Partially	182	13	1
Mohlin *et al.* (2020)	Partially	179	6	0
Diekmann (2004)	Completely	174	-	95
Engelbrecht-Wiggans *et al.* (2007)	Completely	160	40	82
Maqbool *et al.* (2017)	Completely	156	3	5
Yang and Liu (2019)	Completely	150	20	0
Haruvy and Katok (2013)	Completely	128	-	50
Scharlemann *et al.* (2001)	Completely	120	-	265
Brocas *et al.* (2014)	Completely	118	8	3
Georganas *et al.* (2015)	Completely	116	10	43
Song (2008)	Completely	108	4	34
Roberts and Goldstone (2011)	Completely	106	18	16
Halevy and Phillips (2015)	Completely	101	-	8
Zeitzoff (2014)	Completely	100	4	27
Kausel (2017)	Completely	98	49	3
Gneezy *et al.* (2010)	Completely	88	14	36
Kostelic (2020)	Completely	87	-	1
Leland and Schneider (2015)	Partially	78	4	1
Devetag and Warglien (2003)	Completely	67	1	41
Benndorf *et al.* (2017)	Partially	66	11	4
Collard and Oboeuf (2013)	Partially	66	65	2
Napoli and Fum (2010)	Completely	64	6	0
Camerer and Ho (1999)	Partially	54	6	854
Srivastava *et al.* (2000)	Completely	46	-	0
Gibbons and Boven (2001)	Completely	44	13	8
Adriaanse (2011)	Completely	42	-	2
Huoviala and Rantala (2013)	Completely	40	1	24
Hillebrandt *et al.* (2011)	Completely	24	-	26
Kang y Camerer (2018)	Partially	23	-	1
Johnson *et al.* (2002)	Partially	20	2	212
Martin *et al.* (2014)	Completely	4	4	7
McCabe *et al.* (2003)	Completely	-	-	301

Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

The mean and standard deviation of the sample were calculated; the mean of the sample sizes of the 63 items was 802.49 individuals and the standard deviation was 3825.93 individuals. The extremely high deviation suggested that the data are very heterogeneous. We observed five outliers that could bias these two measures as indicators of the whole sample. The maximum number of observations used was 31 120 from Regner (2014) and the second highest was 2916 observations from Kearns *et al*. (2009). These two experiments recorded online responses, which allowed such large samples. The third and fourth outliers had 2733 and 1521 observations, respectively, and corresponded to Sah and Read (2020) and Johnson and Rips (2015). The reason they had relatively large samples was that both consisted of a set of posterior experiments. Conversely, the fifth outlier was presented by Martin *et al.* (2014), which was an experiment with four chimpanzees using games. If removing those five outliers in the calculations, the mean becomes 180.4 individuals and the standard deviation is 128.54, being more representative figures. The maximum and minimum are now 509 and 20 observations from Franzen and Pointner (2013) and Johnson *et al*. (2002). Another feature of the samples is that 90 % of the experiments used college students as study participants. A couple of papers used only one gender in their research: only males to study testosterone in games (Huoviala and Rantala, 2013) or only females (Hillebrandt *et al.*, 2011) to test theoretical hypotheses, leaving gender constant. Other studies used chimpanzees (Martin *et al*., 2014) elite athletes (Collard and Oboeuf, 2013), Google users (Regner, 2014), hospital patients (Tarrant *et al*., 2008), war victims (Zeitzoff, 2014), Amazon workers (Johnson and Rips, 2015), and residents of a neighborhood (Adriaanse, 2011). Furthermore, participants' reward was clearly specified in 82.08 % of the items; we were unable to determine whether participants in the other 17.91 % of the items received any reward. In most of the experiments in which participants received a reward, the reward was a monetary incentive. The remaining experiments rewarded their participants through academic incentives, such as course credit (Roberts and Goldstone, 2011; Yang and Liu, 2019), or an increase in a subject grade (Kostelic, 2020).

If considering the sessions carried out, it is found that 71.64% clearly specified the number of experimental sessions, while the other 28.35% did not provide such information. There could be many reasons for this. On average, 16.68 (±17.1) experimental sessions were performed among the papers that clearly indicated the number of sessions.

The selected papers were analyzed taking into account how they are organized according to the broad classification made by Camerer and Ho (2015), and assigning each study to a game typology. The game types were cognitive hierarchy (level-k models are also similar), quant response, learning, sophistication, and social preference models. Although the sophistication models are an extension of the learning models, we merged them into our classification scheme.

In conducting the search, we learned that each publication selected was an experimental study looking at psychological variables to determine how individuals make decisions by observing the actions of others. Considering the role of social behavior in these games, it is reasonable that the results of most of the papers were models of social preference. Specifically, we determined that 50.74% of the papers used social preference models. These papers studied how the social behavior of others affects our own behavior. For example, Scharlemann *et al*. (2001) tested how a smile can change players' strategy, and Bellemare *et al*. (2018) measured guilt sensitivity in dictator games. The second most frequent type of models used were learning or sophistication models (25.37 % of all papers), which were used when the authors wanted to study the decision-making process in social behavior (Gneezy *et al*., 2010; Ho and Weigelt, 2005), for this reason some of them were mixed with a social preference model, as in Bernasconi and Galizzi (2010) and Martin (2017). 14.92 % used cognitive hierarchy or k-level models due to the study of the initial conditions of a game through rationality, such as Berger *et al.* (2016) and Dufwenberg *et al.* (2011). In addition, they used cognitive hierarchy models due to the examination of how individuals interpret information, as in Jin (2020) and Kostelic (2020). Finally, 8.95 % used quantal response models due to non-precise equilibria and actions, as in Brocas *et al*. (2014), where weighted imperfect attention was studied as a way of looking at weighted imperfect strategies. In addition, imperfect market equilibria as a result of weighted strategies are observed in Lindsay (2019) and Fugger *et al*. (2016).

It is important to point out that this classification was made by first considering the classification given by the authors to their article; secondly, in the cases in which the research did not fit into any of the categories, the model that most closely resembles it was used. Therefore, this classification does not imply that the articles do not contemplate other less relevant variables from a different Camerer model. In fact, we found at least four articles that assigned them to different categories. Brocas *et al.* (2014) and Moinas and Pouget (2013) are cognitive hierarchy and quantal response models because bounded rationality causes players to make small errors. In addition, Lindsay (2019) presents a quantum learning and response model and Georganas *et al.* (2015) proposes a cognitive learning and hierarchy model, i.e., a sophistication model.

Contributions to the state of the art

Considering the above and the methodology used in the systematic review, the main contribution of this study would be to group the different papers around the main hypotheses raised in them, understanding that it can help future researchers.

Social preferences

According to Camerer (2010), social preference models convert monetary rewards into utilities and behaviors. Sociability can change players' strategies into more acceptable actions, a topic that worth studying. It can be observed in Table 2 that most of the articles focus their efforts on studying guilt and reciprocity as generators of non-rational equilibria. Articles labeled as "studying guilt" examine the role of guilt (Bracht and Regner, 2013; Giaccherini and Ponti, 2018), guilt aversion (Attanasi *et al*., 2019; Bellemare *et al*., 2018; Charness and Dufwenberg, 2006), and how guilt is used to manipulate the actions of others (Cardella, 2016). Articles on reciprocity investigate how reciprocity shapes behavior, such as Diekmann (2004) and Franzen and Pointner (2013), but also when reciprocity is not as important, such as Chen and Houser (2019). The third most frequent theme, which could be an extension of reciprocity, is the study of trust: examining whether trust is built through reciprocity (Song, 2008); how social inclusion influences behavior and trust (Hillebrandt *et al*., 2011); and how individuals trust each other across cultures (Póvoa *et al*., 2020; Zeitzoff, 2014). Reciprocity, trust, and blame can be used to study the behavior of social groups (Yang and Liu, 2019) and how these social groups trust each other by looking at how they share public goods (Adriaanse, 2011) and also to look at their behavior in negotiations and conflicts in a group (Halevy and Phillips, 2015). Additionally, there is another subcategory: biopsychology, which is the study of how physiological changes influence behavior, whether by testosterone (Huoviala and Rantala, 2013) or by a smile (Scharlemann *et al*., 2001).

Table 2
Social preferences

Article	Experimental	Label
Gibbons and Boven (2001)	Completely	Decision making
Scharlemann *et al.* (2001)	Completely	Biopsychology
Diekmann (2004)	Completely	Reciprocity
Charness and Dufwenberg (2006)	Parcialmente	Guilt
Song (2008)	Completely	Trust

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Article	Experimental	Label
Halevy and Phillips (2015)	Completely	Management and conflict
Kearns *et al.* (2009)	Completely	Network
Song (2009)	Completely	Trust
Adriaanse (2011)	Completely	Common good
Napoli and Fum (2010)	Completely	Reciprocity
Hillebrandt *et al.* (2011)	Completely	Trust
Bracht and Regner (2013)	Completely	Guilt
Sacconi *et al.* (2011)	Completely	Reciprocity
Franzen and Pointner (2013)	Parcialmente	Reciprocity
Huoviala and Rantala (2013)	Completely	Biopsychology
Regner (2014)	Parcialmente	Reciprocity
Ackermann *et al.* (2016)	Completely	Reciprocity
Zeitzoff (2014)	Completely	Reciprocity
Cardella (2016)	Parcialmente	Guilt
Halevy and Phillips (2015)	Completely	Management and conflict
Mäs and Nax (2016)	Completely	Networks
Macro and Weesie (2016)	Parcialmente	Unequality
Kausel (2017)	Completely	Emotions
Bellemare *et al.* (2018)	Completely	Guilt
Woon (2018)	Parcialmente	Management and conflict
Giaccherini and Ponti (2018)	Completely	Guilt
Peeters and Vorsatz (2018)	Parcialmente	Guilt
Chen and Houser (2019)	Parcialmente	Reciprocity
Attanasi *et al.* (2019)	Parcialmente	Guilt
Morell (2019)	Completely	Guilt
Yang and Liu (2019)	Completely	Social groups
Póvoa *et al.* (2020)	Completely	Trust

Cognitive hierarchy

Cognitive hierarchy focuses more on how initial conditions can influence a game, i.e., belief inconsistencies. As can be seen in Table 3, these initial conditions can be influenced by the rationality level of individuals (Jin, 2020; Johnson and Rips, 2015) or by the strategic implications of the player's awareness of the existence of a game (Kostelic, 2020). In addition, the role of memory (Devetag and Warglien, 2003) and attention (Brocas *et al.*, 2014) are other points of study in relation to an agent's reference point. Finally, the psychological framework (Dufwenberg *et al.*, 2011) represents an interesting insight in the cognitive situation of players.

Table 3
Cognitive hierachy

Article	Experimental	Label
Johnson *et al.* (2002)	Parcially	Rationality
Devetag and Warglien (2003)	Completely	Memory
Dufwenberg *et al.* (2011)	Parcially	Frame
Brocas *et al.* (2014)	Completely	Atention
Moinas and Pouget (2013)	Parcially	Negociation
Johnson and Rips (2015)	Completely	Rationality
Georganas *et al.* (2015)	Completely	Rationality
Berger *et al.* (2016)	Parcially	Rationality
Benndorf *et al.* (2017)	Parcially	Rationality
Jin (2020)	Parcially	Rationality
Kostelic (2020)	Completely	Awareness

Quantitative response

Quantitative response models are used when players have accurate beliefs but mistake their actions. Such errors could come from information loss (McCubbins and Turner, 2014) or asymmetric information (Lindsay, 2019). It should be noted that players may have accurate beliefs, but if they are not allowed to observe all possibilities, they will make errors. In fact (Brocas *et al.*, 2014) established a model in which it does not matter how accurate beliefs are if players do not pay enough attention (the attentional framework is built through a cognitive hierarchy model). Information inconsistencies are also reflected in auction studies. These studies investigate the different mechanisms of auctions (Engelbrecht-Wiggans *et al.*, 2007; Fugger *et al.*, 2016) in which individuals know what they want (winning the auction), but players can make mistakes if the information is not complete (Haruvy and Katok, 2013).

Table 4
Quantitative response

Article	Experimental	Label
Haruvy and Katok (2013)	Completely	Auctions
McCubbins and Turner (2014)	Completely	Loss of information
Moinas and Pouget (2013)	Partially	Negotiation
Leland and Schneider (2015)	Partially	Loss of information
Sah and Read (2020)	Completely	Loss of information
Lindsay (2019)	Partially	Asymmetrical information
Engelbrecht-Wiggans *et al.* (2007)	Completely	Auctions
Fugger *et al.* (2016)	Partially	Auctions

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Learning

Learning models suggest changes in strategy because players are learning as the name implies. Because the reference point is the state of change, these models can be adopted with others. Sometimes, players' learning depends on their rationality, so they will be mixed with cognitive hierarchy models (Georganas *et al*., 2015). However, when change arises as a result of an asymmetric information situation, it may blend with quantal response models (Lindsay, 2019), which could result in different learning strategies in negotiation environments (Srivastava *et al.*, 2000), leading to some changes in communication between agents (Wu, 2018). However, the problem comes when changes in sociability are observed, for example, how the trust-building process occurs (Ho and Weigelt, 2005), how reciprocity emerges (McCabe *et al*., 2003), or how social groups coordinate (Roberts and Goldstone, 2011). Also, competition for a certain social status can lead players to improve (Laing and Morrison, 1974) because rewards are important to advance (Maqbool *et al.*, 2017). However, motivation is not the only means of learning. Weighted experience is important in order not to make the same mistakes (Camerer and Ho, 1999) even though past behaviors can be repeated (Collard and Oboeuf, 2013).

Table 5
Learning

Article	Experimental	Label
Laing and Morrison (1974)	Partially	State game
Camerer and Ho (1999)	Partially	Weighted experience
Srivastava *et al.* (2000)	Completely	Negotiation
McCabe *et al.* (2003)	Completely	Reciprocity
Ho and Weigelt (2005)	Partially	Trust
Gneezy *et al.* (2010)	Partially	Planning
Bernasconi and Galizzi (2010)	Completely	Network
Roberts and Goldstone (2011)	Completely	Social groups
Collard and Oboeuf (2013)	Partially	Sports
Martin *et al*. (2014)	Completely	Animal cognition
Tarrant *et al*. (2008)	Completely	Trust
Georganas *et al.* (2015)	Completely	Rationality
Rauhut (2015)	Partially	Motivation
Wu (2018)	Partially	Communication
Kang and Camerer (2018)	Partially	Anxiety
Maqbool *et al.* (2017)	Completely	Motivation
He and Wu (2020)	Completely	Commitment
Lindsay (2019)	Partially	Asymmetrical information
Mohlin *et al.* (2020)	Partially	Likehood weight

Discussion

Some authors show differences between psychological game theory and other behavioral approaches to game theory. According to psychological game theory, one attempts to incorporate the beliefs of others about an individual's actions directly into his or her utility function. According to the authors, "this differs from the known applications of psychology to economics and political science, where biases, heuristics, etc. are used to explain observed behaviors" (DeAngelo and McCannon, 2020, p. 2). Under this theoretical framework, one can describe one's own or others' beliefs, on which preferences in decision making are crucial. This theory would incorporate emotions, reciprocity, image concern and self-esteem into the economic analysis (Battigalli and Dufwenberg, 2020). The above is at odds with the findings of the present review, as BGT also uses beliefs, emotions, reciprocity, and self-esteem as variables in its studies. It also goes against other findings such as those of Goeree and Louis (2021) who demonstrate the virtues of behavioral game theory in predicting stated beliefs.

The difference between the two approaches may be due to the different types of analysis common in economics and psychology rather than to the study of different phenomena or variables. According to Nagatsu and Lisciandra, this "may be explained by the specific way in which economists conduct equilibrium analysis of aggregate-level outcomes in their practice, and by the reluctance of psychologists to engage fully in such practice"(2021, p. 289).

Conclusions

The review shows that some articles refer to 'psychological game theory' while others use the term 'behavioral game theory'. In addition, authors who classified their studies as psychological did not do so as behavioral, being intrinsically related to the bibliographic references and keywords that were used in each specific publication, meaning that the vocabulary used in a specific publication tends to follow the accepted terms that have been first used in the supporting references for that research. In addition, the article that described their work in terms of behavioral (psychological) games used references that also described behavioral (psychological) games but not psychological (behavioral) games. Specifically, one of the main findings of this review is that all behavioral game theory articles cite Camerer (2010), and all psychological game theory articles cite Geanakoplos *et al.* (1989), Battigalli and Dufwenberg (2009), or Balafoutas (2011). This could imply the reason why psychological game theory and behavioral game theory are treated as two different research areas, as one does not normally cite the other. However, there are no differences between them in terms of research focus, which, if found, would have implied a major limitation. If those using psychological (behavioral) games do not use the same terminology as those using behavioral (psychological) games, then some articles could be investigating the same topics or, at the very least, assume that there are new lines of research when in fact they have already been studied under the opposite term. Despite these two ways of assigning games using bounded rationality, the psychological variables involved are similar. For example, studies on guilt, trust, motivation, and reciprocity are widely used to investigate their strategic implications. In addition, variables such as attention span or anxiety proneness mainly affect information loss in games. This loss of information is sometimes the reference point for studying different auction systems, failures in negotiations, communication errors and conflict resolution. Other articles include the examination of intelligence, consciousness, and memory as psychological perspectives on deviations in game theory. These deviations are sometimes unintentional, but respond to a player's cognition. In fact, the study of changes in cognition to approach competitive equilibrium was used as a form of learning in games. For example, players may first apply a strategy that might change based on greater mental clarity as the game unfolds. In summary, three main types of variables can be noted: emotional, social and cognitive. Additionally, we found that there were psychological variables that represented the objectives of the studies given an economic environment or variables that were used as a

Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

psychological environment to explain economic behavior. Through this mix of disciplines, we can better understand human behavior in game theory, in addition to the theoretical framework for measuring how individuals may behave when facing uncertainty.

Although the objective was to analyze the different studies grouped around the two approaches mentioned, behavioral game theory and psychological game theory, a limitation of this paper can be that there are a large number of articles that include psychological or behavioral variables in the experiments conducted with game theory, which do not fall under either of these two approaches. For future research, it would be interesting to include other search criteria such as social game theory.

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Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

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Printed ISSN: 1390-6291; Electronic ISSN: 1390-861

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