Strategic Interactions in College Students' Romantic Relationships: Exploring the Dynamics Through Game Theory

Xixiang Zhao[1,a,*]

[1]*School of mathematical Sciences, Tongji University, Siping Road, China*
a. 2152542@tongji.edu.cn
**corresponding author*

Abstract: With the improvement of living standards, people's attention to intimate relationships is also increasing. This article takes the love relationship of college students as an example and uses game theory methods to analyze some phenomena in intimate relationships. The article first introduces the basic concepts and theories of game theory, and then explores the game problems in college students' love relationships from aspects such as Nash equilibrium and prisoner's dilemma. Research has found that there are multiple Nash equilibria in the game of college students in romantic relationships, but the existence of prisoner's dilemma often leads to difficulties in achieving optimal decision-making between lovers. And research has found that the existence of irrationality and the strategy of tit for tat encourage both regions to take proactive measures to handle conflicts. In infinite games, the larger the discount factor, the more likely both sides are to choose a positive way to handle conflicts. Finally, this article proposes some suggestions to help college students better handle game problems in romantic relationships.

Keywords: game theory, romantic relationships, Nash equilibrium, conflict response

1. Introduction

Humans are born with a sense of belonging and the need to love others, and when these needs are met, intimate relationships are formed. With the continuous improvement of people's living standards, according to Maslow's theory of needs, people are paying more attention to spiritual needs. Correspondingly, the level of attention paid to intimate relationships is also constantly increasing.

In the process of deepening intimate relationships, people will encounter many problems and contradictions due to various reasons. Furthermore, people can have different strategies to address these issues, and different combinations of strategies lead to varying degrees of development and changes in intimate relationships. This article aims to explain some phenomena in intimate relationships from the perspective of game theory and provide corresponding suggestions [1-3].

A romantic relationship is a typical intimate relationship. According to Stenberg's theory of love triad, intimate relationships are an important component of love, so studying romantic relationships has representative and general value. The learning and living environment of college students is relatively free, and their physical and mental development is complete. Their pursuit of emotions is relatively pure, and their decision-making process is less influenced by external factors such as

economic conditions, parenting issues, social public opinion, and pressure from older age. The determining factor for the degree of intimacy is mainly related to the emotions of the two individuals. Therefore, selecting college students as the research object can reduce unnecessary factor interference, making the research results more authentic and meaningful for reference [4].

Previous research has mainly focused on the field of psychology, attempting to understand the essence and influencing factors of intimate relationships, but most of these studies only describe phenomena without conducting in-depth quantitative analysis. Although psychology has made important contributions to the study of intimate relationships, the limitations of such research have become increasingly apparent due to the complexity and diversity of intimate relationships.

On the other hand, game theory is an extremely extensive theory that provides us with powerful tools to understand and solve many decision-making problems. The various models and theories involved in game theory, such as Nash equilibrium and prisoner's dilemma, can provide us with rational decision-making guidance in various complex decision-making environments.

However, the application of game theory to the study of intimate relationships is very rare. Although some studies attempt to quantify some elements of intimate relationships from an economic or sociological perspective, these studies often remain superficial and do not delve into the dynamics and complexity of intimate relationships. Therefore, using game theory to study issues in intimate relationships not only has certain innovation, but also has great research value.

Game theory methods can be employed to better understand and describe the interactions and decision-making processes in intimate relationships. The dynamics of intimate relationships can be simulated by establishing models, exploring how individuals' behavior and decisions in intimate relationships are influenced by each other, and how this influence, in turn, is affected by the relationship between the two parties. In this way, it is possible to gain a clearer understanding of the process of the formation, development, and breakdown of intimate relationships.

More importantly, through this type of research, people can be provided with more practical advice to help themselves solve problems in intimate relationships. This quantitative analysis method can help us better identify and handle conflicts and dilemmas in intimate relationships. For example, Effective strategic recommendations for individuals in distress can be provided by analyzing models of the prisoner's dilemma. In addition, the exploration of better ways to maintain and strengthen intimate relationships can be undertaken through game theory methods.

"Exploring the dynamics of close relationships through the lens of game theory holds significant scholarly merit. Such inquiry not only enriches our comprehension of personal bonds but also offers actionable insights for the effective management and preservation of these connections. The fusion of game theory with the study of intimate relationships heralds the emergence of a novel field of study, brimming with boundless opportunities for future exploration."

1.1. Introduction to Game Theory and Related Theories

Game Theory is a theory that studies the mutual influence of various strategies in the decision-making process. In game theory, each participant makes their own decisions in the hope of maximizing their own profits. Game theory includes cooperative and non-cooperative games. In non-cooperative games, each participant attempts to maximize their own gains without considering the gains of other participants. Nash Equilibrium is one of the important concepts in game theory, which refers to each participant choosing the optimal strategy given the strategies of other participants, so that no one is willing to change their own strategy. Nash equilibrium is a non-cooperative game outcome that is not based on cooperation or compromise, but rather on the optimal decision of each participant. The Prisoner's Dilemma is a very famous example in game theory, which describes the dilemma faced by two participants in the decision-making process [5]. In this example, both participants are arrested and interrogated separately, and they need to choose whether to cooperate or betray each other. If

both individuals choose to cooperate, then they can both receive a lighter judgment. But if one person chooses to betray and another chooses to cooperate, the betrayer will receive a lighter judgment, while the collaborator will receive a heavier judgment. Therefore, each participant faces a dilemma: whether to betray or cooperate. In the prisoner's dilemma, Nash equilibrium is a very valuable concept. Through Nash equilibrium, the optimal strategy of each participant and the outcome of the entire game can be understood. In the prisoner's dilemma, the optimal strategy is usually betrayal, as betrayal can result in a lighter verdict. But this strategy may also lead to other participants choosing to betray, resulting in a lower-than-expected outcome of the entire game. Therefore, Nash equilibrium has important application value in prisoner's dilemma. In the context of multiple prisoner's dilemmas and the introduction of irrational participants, the Nash equilibrium of prisoner's dilemmas will change [1], which is also what this article will need to use in the future.

1.2. Game Theory Problems in College Students' Love Relationships

Taking the love relationship among college students as an example, this paper explores the game problem involved. Firstly, the decision-making process of college students in romantic relationships was analyzed from the perspective of interactive decision-making. Then, the Nash equilibrium theory was applied to discuss the Nash equilibrium in college students' romantic relationships. Finally, combined with the prisoner's dilemma model, the difficulties and choices faced by college students in romantic relationships were analysed.

1.2.1.Model establishment

In the process of getting along, couples inevitably encounter conflicts of all sizes. Sometimes it appears to outsiders that this matter can be easily resolved, but the results often become very bad. Next, this article attempts to explain this phenomenon from the perspective of game theory. Research has shown that there is a significant correlation between conflict coping styles and intimate relationship satisfaction among couples [6]. Therefore, this article will consider the intimate relationship satisfaction of each couple as a benefit function and use different conflict coping styles as action choices to examine the corresponding game relationships. According to the Intimate Relationship Conflict Coping Style Scale, the coping styles of couples after conflicts can be divided into six types: compromise, control, separation, behavioral response, obedience, and avoidance [7]. But for the convenience of subsequent model establishment, these six methods will be simplified into two categories. And this article makes the following assumption: the advantages and disadvantages of the strategy combination will be determined based on the profits of both parties, assuming that both men and women are equal, and decision-making is not divided into priority.

1.2.1.1.Prisoner's Dilemma Model

After encountering conflicts, our decision-making can be simplified into two types: positive response and negative handling [7]. Among them, positive response refers to behaviors that are beneficial for repairing relationships, such as actively communicating to solve problems and making good, while negative handling refers to verbal abuse, violent behavior, oppression, control, responsibility, cold violence, and other behaviors that are not conducive to repairing relationships. There is a fact that in a conflict, a positive resolution attitude or constructive conflict resolution coping style is beneficial for improving intimacy satisfaction, while a negative handling style is not conducive to improving intimacy satisfaction. Therefore, if one party holds a positive attitude and the other party holds a negative attitude, then the positive party will always suffer more. At this point, the conflict is difficult to resolve, and the positive party is left out, while the other party's satisfaction with the other party's positive attitude will increase. After adopting negative strategies, they are less affected by the other

party's negative strategies due to their tendency towards avoidance. If both parties bow their heads to admit their mistakes and actively communicate and reconcile, their intimate relationship will be repaired, and their satisfaction with the other party's intimate relationship will increase. If both parties do not bow their heads to admit their mistakes, both parties will have some losses. Based on this theoretical basis, the profit functions that different strategy combinations bring to both parties can be established:

Let the income matrix of the male side be A= [a11, a12; a21, a22], and the female side B= [b11, b12; b21, b22] Tables must appear inside the designated margins, Table 1-2.

Table 1: strategic expression matrix

Male/Female	positive	negative
1. positive	(a11, b11) (a11, b11)	(a12, b12) (a12, b12)
2. negative	(a21, b21) (a21, b21)	(a22, b22) (a22, b22)

Table 2: profit functions of each party

Our own decision/the other party's decision	positive	negative
positive	k11	k12
negative	k21	k22

(k=a or b)

Let K=[k11, k12; k21, k22]

Furthermore, based on the symmetry assumption, it can be inferred that A=K and B is the transposition of K (That means for any i,j,there is $b_{ij}=k_{ji}$)

Based on the above theoretical assumptions, the following inequality relationship can be inferred

$$k21>k11, k21> k22, k11>k12, k11>k22$$

Furthermore, the following relationship can be obtained:

(1) If k22>k12, then there is

$$k21>k11>k22>k12$$

According to the line drawing method, the Nash equilibrium of this game is: (negative, negative). This is the classic prisoner's dilemma model. It has strong practical significance: in a conflict, for both partners, adopting positive communication is the optimal decision, but for each individual, the optimal choice is to handle it negatively, which leads to the conflict being unresolved and the satisfaction of the intimate relationship between the two parties decreasing.

(2) If k22<k12

Then there are $k21>k11>k12>k22$

It does not exist as a pure strategic Nash equilibrium, but it can still be seen that it has practical significance: although both parties adopt a negative attitude after conflicts occur, which is detrimental to both parties and seriously affects the satisfaction of intimate relationships, both parties expect the other party to bow their heads and admit their mistakes first, in order to obtain greater benefits, that is, a cowardly game.

1.2.1.2.Prisoner's Dilemma Model of Repeated Games (Comparing Different Strategies: Cold hearted Strategy, Tooth for Tooth Strategy, etc.)

In fact, in life, people don't just make a decision once. There will always be conflicts between couples, so each decision will consider the impact of this decision on the future, and it is necessary to establish a repeated game.

For the convenience of analysis, the article adopt the game theory of the first hypothesis mentioned above, namely the prisoner's dilemma model.

For finite repeated games, according to relevant theories [5], the refined Bayesian Nash equilibrium is still: each choice of both parties is dealt with negatively. This observation appears to be at odds with certain real-world instances: how is it that some partners consistently opt for proactive dialogue to address issues, thereby optimizing the collective benefits for both individuals? To better explain phenomena in real life, this article extends the model in the following two directions.

1.2.1.3.infinitely repeated games

The article set the discount factor to r and select a ruthless strategy for the male partner: that is, the first decision adopts a positive response approach. In future decisions, if the woman chooses to cancel the extreme attitude, the man will choose to cancel the extreme attitude in the future.

Next, under the assumption of this strategy, is the ruthless strategy the optimal strategy for the female partner?

Consider the outcome of each decision: if they choose a negative attitude, in future games, as the man always chooses a negative attitude, choosing a negative attitude for the woman is the best strategy.

Looking at the first choice again, if the following inequality is met, then the woman is not motivated to deviate from the cold strategy, equation (1):

$$k21 + k12 \times (\sum_{n=1}^{\infty} r^n) \leq k11 \times \sum_{n=0}^{\infty} r^n) \tag{1}$$

Solution: $r \geq (k21 - k11) \div (k21 - k12) \ (0 < r < 1)$

It can be seen that the result is closely related to the relationship between r and: when r is relatively large, both parties choose a cold strategy, which is Nash equilibrium. The result of the game is that both parties choose positive coping methods to handle conflicts each time.

1.2.1.4.Further discussion: Consider irrational factors

Change the rational assumptions in the above models. That means it can be assumed that the rational probability of one of the two individuals is P, and the irrational probability is (1-P) (Without losing generality, let it be the female side). The irrational strategy is always "tit for tat": that is, choosing a positive coping strategy for the first time and imitating the behavior of the other person every time the strategy is chosen. Let the man always maintain rationality [8].

Here, let K= [-6, -3; -8, -4] which is consistent with the articles' previous assumptions. Through analysis, it can be found that in a finite number of game processes, as long as p>1/2, except for the last two times, positive coping methods are chosen in each previous time to form a Nash equilibrium[9].

Furthermore, it can be proved that if both men and women are assumed to have a positive probability of irrationality, if the number of repetitions is sufficient, the Nash equilibrium will tend

towards both parties choosing to communicate. In fact, research has shown that irrational emotions contribute to cooperative behavior (i.e. both parties choose positive ways) [10-11].

2. Research results

Based on the previous analysis, this chapter summarizes the research results on game theory in college students' love relationships. It is pointed out that there are multiple Nash equilibria in the game of college students in romantic relationships, but the existence of prisoner's dilemma or cowardly game often leads to difficulties in achieving optimal decision-making between lovers. On this basis, in-depth discussions were conducted on the research results. After introducing a more complex repetitive model, based on research results, it was found that discount factors and parameters have a significant impact on game equilibrium: the larger the discount factor, the greater the difference in the impact of one party being positive and the other party being negative and both parties being positive on intimate relationship satisfaction. The smaller the difference in the impact of one party being positive and the other party being negative and both parties being negative on intimate relationship satisfaction, the more likely both parties tend to choose a positive attitude and communicate actively. On the other hand, for groups with irrational possibilities, if the number of games is sufficient, both parties is always chosen "actively respond" as the optimal strategy.

3. Conclusion and suggestions

Research has found that the strategic choices of both parties are closely related to the size of their returns on different choices. In infinite games, the size of the discount factor is also closely related to the Nash equilibrium. In order to achieve the optimal strategy combination for couples and improve their satisfaction with intimate relationships, it is necessary to reduce the difference in benefits between the two strategies chosen by the other party for communication, increase the difference in benefits between the positive and negative strategies of one party and the negative strategies of the other party, carefully consider the impact of each decision on future decisions, and pursue long-term benefits, thereby increasing the size of the discount factor. From the perspective of formulating the income function, if both partners can fully consider each other and treat them, it is easier to obtain the optimal strategy combination and break out of the prisoner's dilemma. The return function can also be changed through moral, contractual, and trust methods, making both partners more inclined to choose active communication. This study provides a systematic and clear explanation of the impact of different conflict coping styles in college students' romantic relationships on their satisfaction with intimate relationships using game theory and provides a reference for the impact of different conflict coping styles on general intimate relationships.

3.1. Model defects and prospects

In the process of establishing a game model in this article, many assumptions were made, and the model was relatively simple. However, games are often more complex and influenced by many factors: research has shown that the results of different conflict handling methods are highly correlated with adult attachment types and the benefits of different strategy combinations are not equal due to differences in physiological structure and social culture between men and women. The selection of parameters originates from relevant psychological papers and common sense, and its credibility needs to be further strengthened for more accurate research.

This article only examines a small portion of the impact of different conflict coping styles in intimate relationships: college student romantic relationships, but there are many types of intimate relationships, such as family and friendship, as well as intimate relationships of different age groups, which require further research.

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