Abstract:

Our experiment tested the question whether people coordinate their decisions when faced in situations where there are multiple Nash equilibriums each favoring a different opponent more. We also tested whether people converge towards a Nash equilibrium decision over repeated trials. Using a variant of the Battle of the Sexes coordination game, we conducted the experiment by having one control group – Game 1: participants cannot talk and anonymous– and two treatment groups – Game 2: participants are given a signal, Game 3: participants can talk. When comparing the data, we found that signaling and talking, in Game 2 and Game 3 respectively, led to a significant increase in total Nash equilibriums. While our data did not support the claim that players converged to a Nash equilibrium, we found that adding additional communication methods, whether it is a signal or talking, does affect player's ability to reach Nash equilibriums.

1. **Introduction**:

   Most people in their life will have to make hard choices and sacrifices. This idea is ever more apparent within the workplace, close friends, family, and romantic relationships. Oftentimes, people desire certain preferences or actions that their partners do not necessarily share exactly with. In these situations, people make sacrifices or coordinate with each other to ensure that all parties are relatively satisfied. This common balancing act found in human relationships is the central phenomenon studied under the "Battle of the Sexes" coordination game. The game inherently forces two players to choose between two Nash equilibriums that favors each partner differently. Our experiment will explore the implications of the "Battle of the Sexes" setup and how people really do make coordination decisions under an empirical setting.

2. **Question:**

   Generally our question was how do people react to a coordination game in which some form of cooperation is necessary to earn a payout? This is because the only way for players to receive payouts is if they make the same decision, (Hawaii, Hawaii) or (New York, New York). But more specifically, we wanted to see if players converged toward Nash equilibrium across multiple rounds of play. In other words, do previous rounds results affected player's decisions of current games. We tested these two questions mostly with our control game. We also wanted to see how having a correlated game (signaling) affects convergence to Nash Equilibrium, and how being able to talk to your partner affects payoffs. To test these last two questions, we created two treatment games.

3. **Identification:**

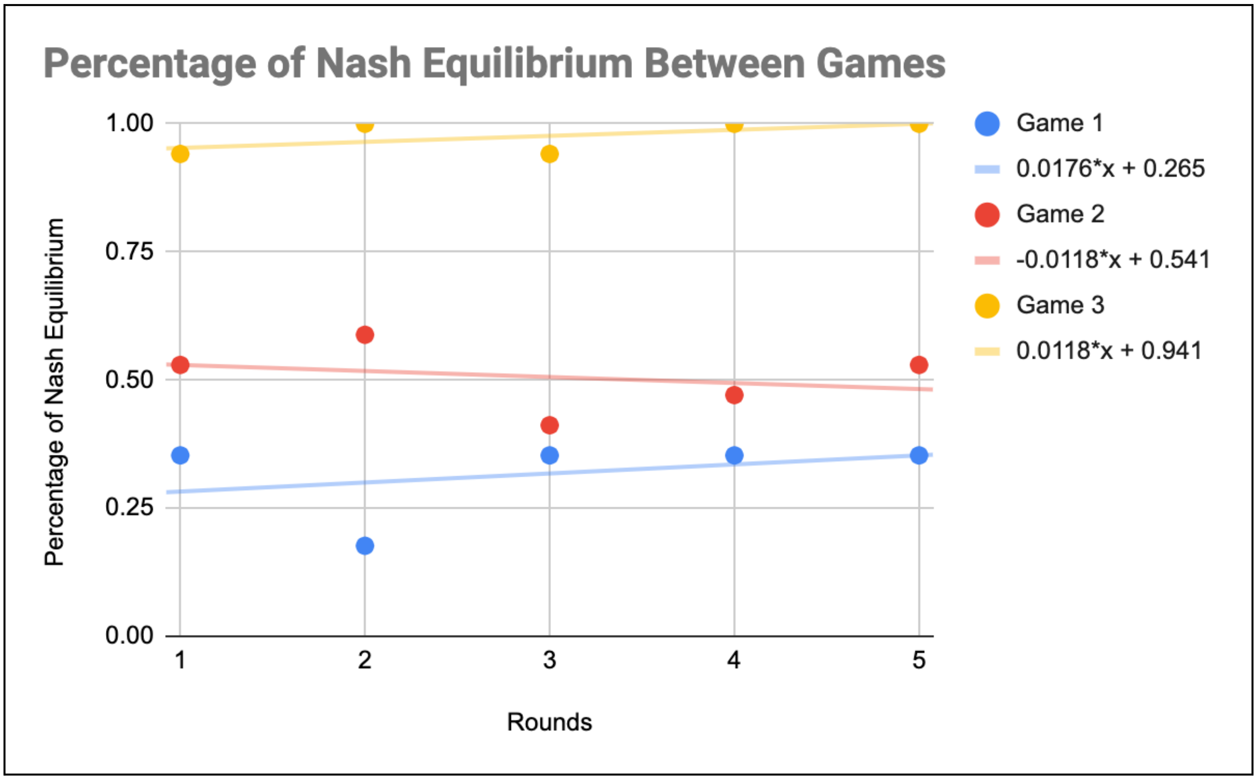
Our game was designed with a payoff matrix in which both players had the option to choose either New York or Hawaii and all pairs were fixed for each game. Because each round players were forced to make a decision with the same partner, we were able to test whether or not there was convergence in each game and if previous rounds affected future play while playing with the same partners.

4. **Experiment:**

To run our experiment, we had the whole class of 34 participants play 3 separate games. The first game was the traditional battle of the sexes coordination game, played anonymously on veconlab with the same partner across 5 rounds. Game 2 was still an anonymous 5 round game on veconlab, but this time we displayed a signal that the participants could potentially use to coordinate their decisions, coordinating based on the signal was not required. The signal we used was a fair coin with New York on one side and Hawaii on the other, which we would flip at the start of each round. Game 3 was a non-anonymous, 5 round set of coordination games in which the two players were allowed to communicate with one another directly as they made their decisions. Both players would then record their decisions and their resulting payoffs on a sheet of paper that we collected at the end of the 5 rounds.

5. **Data and Results:**

Between the different types of games (Game 1: anonymous no-talking, Game 2: signaling, Game 3: talking), we found several statistically significant results. To measure if the treatments – signaling in Game 2, talking in Game 3 – had any effect on the percentage of Nash equilibriums, we did several comparisons of means tests. When measuring the difference between Game 1 and Game 2, we obtained a t-stat value of 3.59. Likewise, when measuring the difference between Game 1 and Game 3, we obtained a t-stat value of 17.92. These results are statistically significant and indicate that the treatments significantly increased the amount of Nash equilibriums in the game. While both treatments increased the total Nash equilibriums played, we found that talking in particular significantly increased the total amount, with the average percentage of Nash equilibrium in Game 3 around 98% compared to 32% in the control treatment.



Another metric that we were measured was the convergence of the Nash equilibrium over the rounds in each game. For each game, we conducted a linear regression to see if there was a slope that was statistically significant from our null hypothesis, which was that there was no change in the amount of Nash equilibrium over successive rounds. We found the respective t-stat values by dividing the beta1 (slope) values by their standard error as shown in the table below.

beta1 (slope)	Game 1	Game 2	Game 3
Point Estimate	0.0176	-0.0118	-0.0118
Standard Error	0.0253	0.0272	0.008
t-stat	0.70	-0.43	1.43

With the t-stat for each of the games below 2, we could not reject the null hypothesis that the slope of the games was 0 and could not conclude that players converged over multiple rounds.

We used the data from game one to determine if the results of the previous round affected a player's decision in the current round. We looked at both whether or not an equilibrium was reached and if the player had played their higher or lower payoff decision in the round prior. We found the following:

P(Switch after no NE)	P(Switch after NE)	P(High|No NE)	P(High|NE)
0.266	0.5	0.840	0.5

P(High|No NE and high)	P(High|NE and high)	P(High|No NE and low)	P(High|NE and low)
0.829	0.667	0.917	0.667

On average players are more likely to play high than low regardless of whether or not a Nash Equilibrium was reached, but they are most likely to play high if no Nash was reached and they played low the previous round. Interestingly, players are more likely to switch after a Nash has been played than if it hadn't.

6. **Other interesting findings:**

In the third game, we saw many pairs playing rock paper scissors or flipping a coin to determine who would get the higher payoff in a given round **or** overall (e.g. who wins three times and who only wins twice). Because players could communicate, they could ensure they would not end up with zero payoff. However, we did not anticipate that players would overcome the problem of deciding who would receive the higher payoff by creating their own coordination system similar to what we saw in the second game. In a poll after completing the experiment, we found that the majority of the class had actually come up with their own coordination system.

7. Limitations:

Collecting data across more rounds in the control trial would have allowed us to better see if groups converged toward the Nash Equilibrium with time. Also, in game 3, instead of having group members make decisions simultaneously in a convenient fashion, we had them write down their decisions, which limited the player's ability to lie.