Mobile Game Theory with Street Gangs

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Abstract. Gang violence remains a persistent public safety problem in Los Angeles. Gang interventionists and community organizers are turning to *proactive peacekeeping*, a process of addressing the underlying structures that cause young people to join gangs such as pervasive poverty and marginalization. Given the increasing prevalence and decreasing cost of mobile technology, there may be opportunities for interventionists to employ technological solutions in their work. However, before such solutions can be deployed, it is necessary to have accurate models of the target users—in this case, gang-involved youth. Of particular interest with regard proactive peacekeeping is their propensity for cooperation. However, given the unique circumstances surrounding the lives of gang-involved youth, traditional laboratory-based experiments measuring cooperation are infeasible. In this paper, we present a novel method of collecting experimental data from gang-involved youth in the Los Angeles area. We design a mobile application based on the classic Prisoner's Dilemma model, which has been used to collect almost 3000 data points on cooperation from more than 20 participants. We present initial results that show despite their unique life circumstances gang-involved youth cooperate at roughly the same rate as university students in classic studies of cooperation. We conclude by addressing the implications of this result for future work and proactive peacekeeping endeavors.

Keywords: Game Theory · Experimental Design · Data Collection

1 Introduction

In his book *Tattoos on the Heart*, Father Gregory Boyle speaks of riding his bike between the poorest neighborhoods of Los Angeles during the late 1980s negotiating peace treaties between rival street gangs [3]. The process was informal and tenuous at best, and although gang violence has declined since the early 1990s, it remains a chronic public safety issue in Los Angeles. While a proper census does not exists, estimates suggest that there are hundreds of unique gangs and tens-of-thousands gang-affiliated individuals in the city [29]. These are distributed throughout the city with particular concentrations in the San Fernando Valley and South Los Angeles. Many of these gangs are territorial in nature, claiming some area as their home turf. As in Chicago, this feature sets Los Angeles apart from many other cities where territoriality appears to be less important. As in other settings, however, Los Angeles gangs appear to be responsible for a disproportionate share of crime, particularly violent crime. Nearly 60 percent of homicides in Los Angeles are thought to be gang related [5].

Father Boyle has since stopped this kind of negotiation, writing in *Tattoos on the Heart*, “Though I don’t regret having orchestrated these truces and treaties, I’d never do it again. The unintended consequence of it all was that it legitimized the gangs and fed them oxygen.” [3]. Today, community organizers and gang interventionists, some of whom are former gang members themselves, are turning to *proactive peacekeeping*. Proactive peacekeeping aims to address the root causes that drive youth into gangs, such as generational poverty, marginalization, abuse, and a sense of hopelessness. It is about giving them options and opportunities beyond violence and building community outside of gangs [16, 28]. Two exemplars of the proactive peacekeeping process include the late Darren “Bo” Taylor, a former gang member who founded Unity One, an organization dedicated to community building and citizen empowerment, and civil rights attorney Connie Rice, who spent decades fighting against problematic policing policies by the Los Angeles Police Department and co-founded the Advancement Project, a racial justice organization that works directly in impacted communities of Los Angeles to build grassroots organizing around public policy change [28]. Part of the proactive peacekeeping process also involves dismantling the stigmas associated with the gang label, which can serve as a barrier to peacekeeping efforts. Therefore, for the rest of this paper we will refer to our study population, gang-involved youth from Los Angeles, as “gamers,” in reference to our use of game-theory and mobile games to study their behavior. In addition, we do not want to further stigmatize youth in our study whose gang involvement may be peripheral or transitory.

The world and our day-to-day interactions are increasingly moving online, and technologies like smart phones are becoming cheaper and more accessible even in areas with pervasive poverty. We feel that technology can help play a role in proactive peacekeeping activities, for instance by giving resource-limited interventionists a new way to reach gamers and provide services on demand. In order to better understand how to best utilize technology in processes such as proactive peacekeeping, it is important to have a clear model of the target users. This paper focuses on the process of collecting data from gamers about their propensity for cooperation using a mobile game.

We focus on understanding the gamers propensity for cooperation as a first step as cooperation is one of the main values associated with proactive peacekeeping. There are also well known game-theoretic models for studying cooperation, the most notable being the Prisoner’s Dilemma, which we utilize in this work. Given the rich history of Prisoner’s Dilemma experiments, it also provides a well-established baseline against which we can compare our data.

Despite this rich history, we cannot directly assume that the gamers propensity for cooperation will align with the accepted baseline since experiments on the propensity for cooperation have typically been limited to populations of university students. Typical members of this population are distinctly different from the typical gamer in terms of socioeconomic status and lived experiences. McCullough et al. found that individuals who experience neglect and personal violence, and are exposed to high levels of neighborhood crime, are more antisocial and tend to cooperate at lower rates [19]. Given these are particularly common experiences among the gamers, we theorize that we may need special behavioral models, requiring new, population specific data. However, due to the unique ecological circumstances surrounding gamers' lives, and a desire to study territorial influences as well, traditional lab-based experiments would be all but impossible to execute. Thus we develop a novel mobile application-based approach to collect the desired data.

In the rest of this paper we describe the mobile phone based experiment which implemented a one-shot prisoner's dilemma game in order to collect data from gamers. We then present initial results which show that counter to our hypothesis, in spite of the unique ecological circumstances surrounding the lives of gamers, we do not need special models to account for their patterns of cooperation. Finally, we discuss areas for future work and implications of this finding for proactive peacekeeping efforts.

2 Related Work

Gang Violence. Current approaches to negotiating peace between gangs are typically informal, short-lived (but see [4]), and are often precipitated by some major violent act such as the March 2019 shooting of Los Angeles-based rapper and activist Nispey Hussle [16, 17]. One potential solution is Just-in-Time Adaptive Interventions, which are designed to deliver targeted, personalized interventions at just the right moment, often via technology such as a mobile device, and is already being explored in public health and education [2, 20, 21]. Patton et al. suggest that threats of retaliation and violence on gang members' Twitter accounts could be used to inform new intervention strategies [23]. However, in contrast to this kind of intervention, we are interested in proactive peacekeeping, which means making a concentrated effort to prevent violence from occurring in the first place, not just stopping retaliation once a violent event has occurred.

Game Theory in the Wild. This field is defined by the study of interactions between independent agents in which the payoff or utility to one agent depends on the actions of the other player(s) [10]. Classic games such as prisoner's dilemma, used in this study, and the ultimatum game can be used to experimentally gauge a population's propensity for traits such as cooperation and fairness. The prisoner's dilemma, although universal and timeless in its abstract form, was formalized using the well-known prisoner scenario in the early 1950s by researchers from the RAND group [25].

As previously mentioned, there is a rich history of experimentation with the prisoner's dilemma scenario and a variety of related models. However, the difficulties that surround working with the gamer population, particularly a lack of trust in authority [3, 16], create a barrier to traditional lab-based experiments, so we conduct our experiments "in the wild." Game theoretic experiments in the wild have been conducted in a variety of contexts. Henrich et al. took traditional ultimatum game experiments to the field, conducting them in small-scale societies across the globe [14]. Other studies have used "natural experiments" such as the choices made by Swedish lottery players and the decisions of movie executives about whether or not to "cold-open" a film [6, 22]. Additionally, there are experiments such as that by Delle Fave et al., which uses a smartphone application to eld test a schedule for metro patrols designed using the theory of Stackelberg security games [8]. There is also an attempt to understand the interaction among rangers and patrollers protecting wildlife in the field within a game theoretic framework[12, 30]. Our work falls between the Henrich et al. and Delle Fave work, using a classic game, the one-shot prisoner's dilemma (PD), embedded in a mobile application. This allows us to compare our results to an established baseline, while collecting data from an otherwise hard to reach population. We are also able to collect location data during game play, which we hypothesize may influence gamers' propensity for cooperation given the significance of territory in their lives.

One-Shot Prisoner's Dilemma. The propensity for humans to cooperate with strangers has presented a long-standing paradox for game theorists [15, 26]. The expected rational behavior of an individual in many common games is to eschew cooperation in favor of a selfish action that maximizes their own utility, often at the expense of the other player. This non-cooperative equilibrium is well-known in the two-person, one-shot Prisoner's Dilemma (PD) game where both players would be better off cooperating with one another, but this strategy is strictly dominated by mutual defection [27]. In numerous experiments stretching back over decades, however, it is clear that cooperation is common in the one-shot PD, in spite of the tactical vulnerability it creates [1]. One possible explanation for the prevalence of cooperation when it is predicted to be rare is that individuals have prior expectations about the likelihood that partners will cooperate (or that failure to cooperate will incur punishment) and that these expectations interfere with the incentives of the experiment [1, 9, 13]. This "homemade altruism" is thought to derive from the role that cooperation plays in routine life experiences that are rooted in repeated interactions and unique social circumstances [14]. One-shot games thus reveal prior expectations precisely because they are artificial. They also illustrate that prior expectations are subject to change, sometimes quite quickly. The one-shot PD, when played repeatedly with random strangers, shows that players adjust their strategies through a sequence equilibria with decreasing frequency of cooperation.

3 The Gamers

Gang membership is not a one-size-fits all problem. Gang researchers now typically think of gang-involvement in terms of degrees of embeddedness [7]. Individuals may be central to the activities of a gang (i.e., high embeddedness), peripheral to it (i.e., low-embeddedness), or occupy various positions between. Individuals may also readily move between social roles that are clearly identified with the gang (e.g., calling shots) and independent of the gang (e.g., parenting). Gang involvement also varies by age and gender, with the degree of involvement higher for young men between the ages of 15-25 [18].

We used an existing network of community members and outreach workers to identify and recruit active gamers to participate in the study. We made a concerted effort to ensure that gamers' privacy was respected and that they were willing participants in the study. Gamers were able to discontinue participation in the experiment at any time with no questions asked. Gamer recruitment and consent procedures were governed by UCLA IRB Protocol #16001755. Gamers were paid for their participation in the study according to the payoff scheme described in Section 4.

We recruited a population of 22 gamers—8 females and 14 males—between the ages of 16 and 25 from four different regions of Los Angeles which have high levels of gang activity. The gamers ranged in their level of gang affiliation and involvement. Ten of the gamers are fully initiated members of a gang with levels of engagement given by "very active," "active," or "not very active." The affiliated gamers are members of five different gangs. The remaining 12 are "not affiliated." These individuals are not officially initiated in gang life, but are familiar with it and have friends who are active.

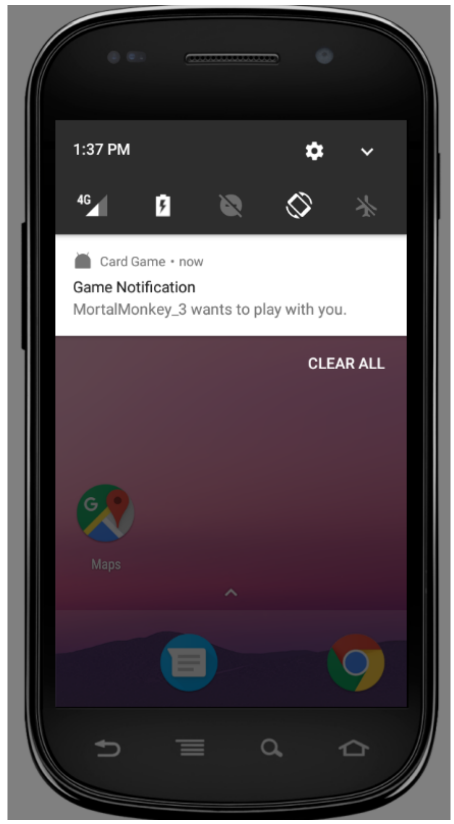
4 Mobile One-Shot Prisoner's Dilemma

The current study aims to achieve a high degree of ecological validity, reflecting decision-making in the real-world settings experienced by gamers. Traditionally, studies in behavioral game theory have been conducted with participants brought into a controlled setting such as a research laboratory. However, it has been shown that tendencies shown by participants in the lab are in line with their behavior outside this setting [11]. Therefore we argue that we can compare the findings from our study "in the wild" to studies which have been carried out in a lab setting.

4.1 Game Design

The mobile one-shot PD application consists of a simple card game with a payoff matrix following the PD form [27]. Cards were chosen because they are a neutral object not belonging to any one particular gang. Figure 1a shows the basic game interface. The game consists of a choice between two playing cards, a king representing cooperation, and a queen representing betrayal. After the gamer chooses a card, the opponent's choice is revealed and the gamer is awarded points according to the matrix shown in Table 1. Gamers received a $50 incentive payment for signing up to play and earned a maximum of $0.25 per game, obtained when the gamer defected against a cooperating opponent (i.e., the temptation payoff). The gamers played against a simple algorithm, where cooperation was deployed as a Bernoulli trial with probability $p = 0.5$.

One-Shot PD Card Game



Game Notification

Fig. 2: Screenshots of (a) the game interface and (b) a game notification from the one-shot PD mobile application

The game was installed as an application on inexpensive android smart phones, which were given to the gamers by coordinators from their communities. Each time the gamers played a game, we collected a unique ID associated with their phone, their move (cooperate or defect), the computer's move, the date, time, and their location in latitude and longitude coordinates. In order to

Table 1: The payoff matrix for the mobile one-shot PD card game.

Card Selection		Payout	
You	Opponent	You	Opponent
King	King	3000	3000
King	Queen	1000	4000
Queen	King	4000	1000
Queen	Queen	2000	2000

constrain payouts and increase the variability of location data collected, gamers were given a limited number of games spaced throughout each day.

4.2 Pilot Test

The game was piloted with four gamers for two months in the fall of 2017. In the pilot, games were spaced evenly from 9AM to 4PM, coming in at the top of each hour. Gamers were given 30 minutes to play each game. If a game was not played within the allotted time, it was forfeit, with no points lost or gained. The gamer then had to wait for the next incoming game notification to play. During the two month pilot, data was collected from 125 games with one of the four gamers accounting for 86 of those instances. During the pilot, the gamers tended to play infrequently and very quickly. Twenty-four percent of games were played within the first 15 seconds of the hour, and 57.6 percent were played within the first 30 seconds. Although the game is not complicated, we felt that this might indicate a lack of attention on the part of the gamers. It became evident that the game needed to be more engaging to better capture the attention of the youth population.

4.3 Changes and Redeployment

After the pilot concluded, several updates were made to make the game more engaging. Rather than sending game notifications at the top of each hour, games were allocated randomly between 9AM and 9PM based on a Poisson distribution with $\lambda = 1/30$ to space games approximately half an hour apart, and a reminder notification was added five minutes before the end of unplayed games to encourage more play. Although gamers were still playing against the computer algorithm, randomly generated usernames were given to the "opponent" for each game to make it feel more realistic. Gamers were also given the opportunity to submit their own username before playing the game for the first time, although for the purpose of keeping gamer identties anonymous, these usernames were not recorded or stored. Figure 1b shows a game notification with a randomly generated username—"MortalMonkey_3". The updated game was introduced into the field in February of 2018 for approximately five months of data collection. Throughout this time, 22 gamers played the game with varying levels of engagement.

Gamers in both the pilot and final experiment were paid at the end of the end of the experimental period. The results of the one-shot PD experiment are described in the next section.

5 Initial Results

A total of 2945 games were played during the study period, with the individual level of of gamer engagement (number of games played) varying greatly. The number of games played by any one of the 22 gamers ranged from 0 to 551, with a mean of 134(+/-135). The median number of games played was 76, with Q1 = 48 and Q3 = 211. We did not find any significant results with regard to the spatial distribution of cooperate and defect plays, however, our findings with regard to the general propensity for cooperation were both interesting and somewhat surprising to the authors.

Figure 3 depicts the patterns of cooperation observed in the one-shot mobile PD experiment. Plot A shows the Gamer IDs on the x-axis, in descending order of number of games played (y-axis). Each gamer is represented by two bars showing the number of games in which they defected (blue) and cooperated (red), respectively. Overall, gamers tended to defect at higher rates than they cooperated, particularly as the number of games played increased. The overall rate of cooperation ranged from zero to 69 percent, with a mean of 15 (+/- 20). Fifteen of the twenty-two gamers engaged in more than 50 games. These gamers had an average cooperation rate of 0.15 (+/- 0.18). Nine of the gamers played more than 100 games, and had a mean cooperation rate of just 0.10 (+/- 0.08).

This decrease in cooperation over the number of games played is reflected in Figure 3 plot C. This plot shows the fraction of games on which each subject cooperated as well as a five-game moving average for the first 80 games.

Finally, plot B shows the first 200 or so games for Gamer L, an unaffiliated female gamer, who played 282 games—the third most active gamer overall. This plot also reflects the deterioration of cooperation over time. During the first 50 or so games, she cooperated at a rate of about 50%, but this quickly deteriorated to less than 10%, consistent with the Andreoni and Miller findings.

6 Conclusion and Implications for Future Work

The most striking finding from these gamers "in the wild" is that they cooperate at quite high levels, at least initially. Indeed, the moving average shown in Figure 3C is consistent with Andreoni and Miller [1], who found that initial cooperation rates of around 38% in the repeated one-shot PD with strangers, declined to less than 20% within 10 rounds of play. Over the long-run, cooperation among strangers deteriorated to less than 10% of all moves, but remained relatively stable at this low level. Our results are consistent with the conclusion that altruism exists at a natural baseline among individuals with considerable exposure to gangs. This cooperation is maintained even under conditions that are particularly inhospitable to cooperation such as in the one-shot PD [24]. We

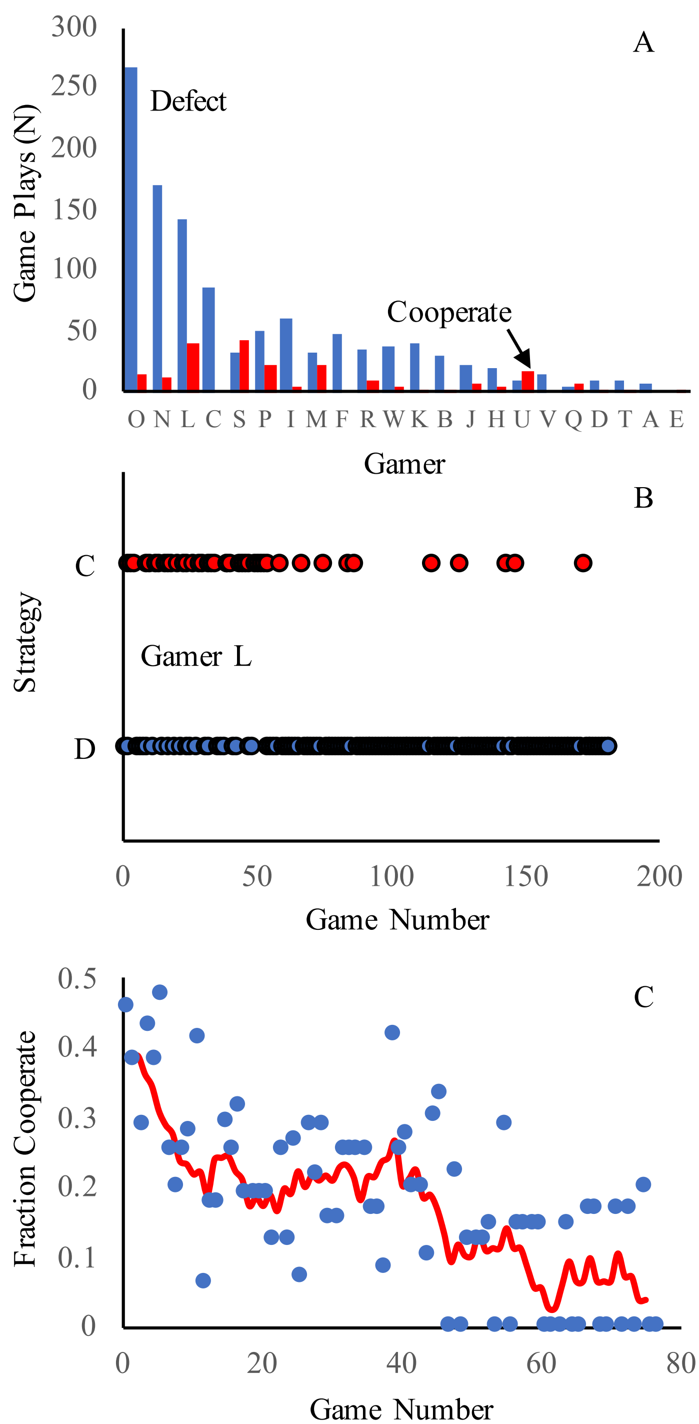


Fig. 3: Cooperation varies across gang-involved individuals and evolves over repeated exposure to one-shot PD games. (A) Number of games in which each subject cooperated and defected. (B) Shift to defection over a collection of one-shot games by Gamer L. (C) Fraction of subjects cooperating over the first 80 games. Line shows a five-game moving average.

conclude not only that we do not need special models to understand cooperative tendencies among active gang members and gang-adjacent individuals, but also that their levels of cooperation are entirely consistent with other normative populations.

In the future, we wish to conduct additional studies of the gamers' propensities for cooperation such as a repeated-PD experiment. Another area of interest is the gamers' inclinations for fairness, which can be measured using classic frameworks such as the ultimatum or dictator games.

Our initial results suggest that interventions seeking to reduce the risk of violence among gang-involved youth can generally start from a very similar baseline propensity to cooperate as other populations. However, there are still many open questions about how to develop and deploy these interventions. Who would be eligible for such interventions, how they would be recruited to participate, who would be responsible for interventions in the field and how such interventions would be received by the community? These open questions raise important legal and ethical implications that deserve careful attention.

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