COOPERATION AND PRODUCTIVITY IN A SIMULATED SMALL GROUP WORK TASK

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Abstract

In the present experiments, I evaluated effects of antecedent- and consequent-based manipulations on cooperation and productivity in a novel group work task. Participants worked in three-person teams on a computer-based task where they could allocate time toward scoring points or assisting teammates. In both experiments, teams were assigned to a restricted (no communication allowed during trials) or unrestricted (communication allowed throughout the experiment) communication condition. In Experiment 1, two teams participated and completed the task in 180-s trials for one of three incentive types: (a) fixed incentive, delivered independent of performance; (b) individual incentive, delivered based on individual score; and (c) collective incentive, based on team total score and divided equally amongst teammates. Probability of incentive delivery also varied and was set to 10% or 100%. I conducted Experiment 2 in a similar manner with eight teams, the fixed and individual incentive types only, and incentive probability was always 100%. Cooperative response requirement also increased across six levels within each trial for both experiments. In Experiment 1, the team in the unrestricted condition engaged in more cooperative responses and was more productive than the team in the restricted condition. No main effects of incentive type manipulations were observed, potentially due to the multiple condition types. Results of Experiment 2 did not replicate the effect of the communication manipulation. However, participants engaged in fewer cooperative responses and were more productive in the individual incentive condition than in the fixed condition. Finally, demand curve analyses were used to evaluate responding across response requirements. Findings demonstrate the utility of the current methodology for examining variables that commonly affect workplace performance.

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Cooperation and Productivity in a Simulated Small Group Work Task

Applied behavior analysis is the application of scientific principles of behavior to improve behaviors of social significance (Baer, Wolf, & Risley, 1968). Applied behavior analytic techniques have been effectively been used to solve problems of societal importance across a wide range of contexts, including autism (e.g., Lovaas, 1987), developmental disabilities (e.g., Neidert, Dozier, Iwata, & Hafen, 2010), education (e.g., Barnett, Daly, Jones, & Lentz, 2004), gerontology (Baker, Fairchild, & Seefeldt, 2015; Burgio & Burgio, 1986), substance use and addiction (e.g., Higgins et al., 1991), gambling (e.g., Nastally & Dixon, 2012), social work (e.g., Thyer, 1999), and others. One sub-discipline of applied behavior analysis, organizational behavior management (OBM; Wilder, Austin, & Casella, 2009), has been particularly successful at using behavior analytic principles to improve employee performance. Work is the single activity toward which Americans devote the most amount of time (Bureau of Labor Statistics, 2017) and, thus, employee performance and related areas are socially significant issues.

The three primary areas of OBM are behavioral systems analysis (Diener, McGee, & Miguel, 2009), behavior-based safety (Boyce & Geller, 2001), and performance management (Daniels & Bailey, 2014). Behavioral systems analysis refers to an approach that treats organizations as behavioral systems, or groups of interrelated components with a shared goal. With this approach, various components of an organization, and their interactions with one another, are assessed and interventions are implemented to create more efficient processes. Behavior-based safety is a focused application of OBM that uses behavior analytic principles to modify work environments and employee behavior to increase safe behavior and reduce injuries in the workplace.

The third area of OBM is performance management, which is a system of management that uses principles of behavior analysis to change employee behavior to help produce meaningful outcomes for the organization. Performance management differs from the other two areas of OBM in that it is employee focused; whereas, in behavioral systems analysis, employees represent only one level of analysis, and performance management targets a broader set of behaviors than behavior-based safety interventions (Wilder et al., 2009).

Performance Management Interventions

Performance management interventions begin by first identifying a particular performance problem and the environmental variables that are likely contributing to the problem with a performance assessment (Austin, 2000). One popular assessment technique is the *Performance Diagnostic Checklist* (PDC; Austin, 2000), which is a semi-structured interview that can be conducted with managers and staff to pinpoint target behaviors and their controlling environmental variables. Following assessment, techniques to address the performance problem can be classified into either antecedent or consequent interventions.

Antecedent interventions involve manipulating factors of an employee's environment prior to when a desired behavior occurs to increase the likelihood that the behavior will occur. Types of antecedent interventions commonly used in organizational settings include goal setting (e.g., Fellner & Sulzer-Azaroff, 1984), task clarification (e.g., Tittlebach, DeAngelis, Sturmey, & Alvero, 2007), job aides (e.g., Slowiak, Madden, & Mathews, 2006), and response effort manipulations (e.g., Casella et al., 2010). These interventions share a common feature that the manipulation is not made to the reinforcement contingency, but rather it helps prompt desirable behavior to make it more likely that the employees will contact reinforcement contingencies that occur in their natural environment. Training is typically also considered a form of antecedent intervention. Training interventions often use a behavioral skills training framework (Miltenberger, 2015; Parsons, Rollyson, & Reid, 2012), which consists of delivery of instructions, modeling the desirable behavior, and rehearsal and feedback until the trainee demonstrates competent performance.

Consequent interventions involve manipulations to workplace contingencies and include performance feedback and incentives. Performance feedback (or feedback) is the delivery of information to an individual about his or her past performance that allows the individual to improve performance on the task (Daniels, 2016). Although the underlying functional mechanisms of feedback are largely unknown (see Duncan & Bruwelheide, 1985; Peterson, 1982), feedback is often considered a consequent intervention (e.g., Sigurdsson, Ring, & Warman, 2018) and is one of the most frequently studied interventions amongst organizational researchers (VanStelle et al., 2012). In reviews of feedback research, Balcazar, Hopkins, and Suarez (1985) and Alvero, Bucklin, and Austin (2001) reported that feedback has been demonstrated to be effective across numerous behaviors, and several variables may affect feedback effectiveness including content, frequency of delivery, the medium through which it is delivered, how accurate it is, and whether it is delivered in group or individual contexts.

Incentives—another type of consequent intervention—are rewards delivered in the workplace contingent on desirable behavior. Incentives are often monetary (Bucklin & Dickinson, 2001; Daniels & Bailey, 2014), but can also take the form of non-monetary tangible items (e.g., food; Kortick & O'Brien, 1996) or activities, such as time off from work (e.g., Austin, Kessler, Riccobono, & Bailey, 1996). The use of monetary incentives dates to the early 1900s, when incentive systems were designed based on Frederick Taylor's contributions to the practice of scientific management (Milkovich & Stevens, 1999, 2000). Taylor originally designed incentives systems using an assumption from traditional economic theory that workers are completely rational (e.g., Persky, 1995) and, thus, would be most productive when wages are proportionally tied to productivity (Milkovich & Stevens, 2000). The prevalence of those early incentive systems decreased due in large part to various social, economic, and political factors occurring in the mid-20th century (Peach & Wren, 1991). Further, economic and psychological research findings suggesting that humans do not behave in a perfectly rational manner (e.g., Tversky & Kahneman, 1981) suggest that Taylor's incentive systems may not have been as sustainable as originally suggested. However, presently, monetary incentives have returned to being one of the most prevalent types of pay systems (Bucklin & Dickinson, 2001), with approximately half of United States companies using monetary incentives as one method to pay employees (e.g., Gross, 1995). This renewed popularity of monetary incentives is likely due to several factors including changes in federal tax law (e.g., Revenue Act of 1978; Milkovich & Stevens, 2000), changes in business practices that led to an increased emphasis on productivity (Milkovich & Stevens, 2000), and increased research evidence improving the effectiveness of incentives (see Bucklin & Dickinson, 2001).

The efficacy of monetary incentives has been well documented in both laboratory and field studies which have consistently found that individuals are more productive when they receive incentives tied to their performance than when paid using fixed, hourly wages (e.g., Allison, Silverstein, & Galante, 1993; Wagner & Bailey, 1998). Jenkins, Mitra, Gupta, and Shaw (1998) conducted a meta-analysis of 39 laboratory experiments, laboratory simulations, and field experiments published between 1960 and 1996 and found that use of individual incentives was significantly correlated with performance quantity across all study contexts. Ultimately, the effects of monetary incentives can lead to large financial gains when applied within organizations. For example, Dierks and McNally (1987) reported that an individualized monetary incentive program for 485 bank employees produced a 200-300% increase in productivity relative to employees working for an hourly wage. Notably, the incentive system used by Dierks and McNally accounted for only 10% of the employees' payroll—the balance was paid as a flat hourly rate. The success that Dierks and McNally observed with using a low percentage of pay earned through incentives is consistent with findings from several laboratory studies, which found little difference in productivity as a function of varying percentage of pay earned through incentives (e.g., Dickinson & Gillette, 1994; Frisch & Dickinson, 1990; Riedel, Nebeker, & Cooper, 1988; cf. Oah & Lee, 2011). These findings suggest that performance increases associated with incentive delivery are primarily due to the presence of the incentive *contingency*, not the percentage of incentive pay relative to base pay (Poling, Dickinson, Austin, & Normand, 2000).

Along with individual incentives, many organizations deliver monetary incentives to groups, or teams, of employees (e.g., Gross, 1995). Most of the research on group incentives has been conducted with small teams of 2-12 members (Honeywell-Johnson & Dickinson, 1999). In a review of the literature comparing small-group and individual incentives, Honeywell-Johnson and Dickinson (1999) reported that, in most studies reviewed, both incentive types produced comparable improvements in performance (e.g., Farr, 1976; Stoneman & Dickinson, 1989). Further, in a meta-analysis of 45 studies and surveys, Stolovitch, Clark, and Condly (2002) found that group incentives increased performance by an average of 45%, whereas individual incentives increased performance by an average of 27%. In addition, group incentives are often perceived to be more satisfying and fair than individual incentives (e.g., Honeywell, Dickinson, & Poling,1997). Satisfaction with the incentive structure may be an important consideration as some research findings suggest that individual incentives may lead to increased stress about financial instability and may be detrimental to employees' overall well-being (see Ganster, Kiersch, Marsh, & Bowen, 2011).

Structurally, group incentives are similar to individual incentives in that delivery of the incentive is certain, frequent, and contingent on clearly defined outputs for both incentive types (Bucklin & Dickinson, 2001; Honeywell-Johnson & Dickinson, 1999). Where the two incentive types differ is in the degree to which performance is directly tied to compensation. In a group incentive arrangement, compensation is partially dependent on other group members' performance, thus weakening the contingency between an individual's performance and compensation. This weakened contingency is an important consideration as some researchers have suggested that the complexity of work settings makes it difficult to evaluate the effects of incentives, even when they are delivered individually (e.g., Poling et al., 2000). That is, various environmental and social factors present in a natural work setting weaken any contingency between performance and compensation, which may severely limit the effectiveness of a group incentive. A final consideration with small-group incentives is the potential relations between incentive arrangement, performance, and a team's social interactions. Group-based incentives may promote increased cooperation amongst team members (Ganster et al., 2011), but few studies have directly evaluated the effects of incentive type on social interactions (Honeywell-Johnson & Dickinson, 1999). Thus, as suggested by Honeywell-Johnson and Dickinson (1999), more research is needed on the effects of social interactions on performance and the effects of incentive type on social behaviors.

Social Behavior

Inherent in the definition of OBM is an implication that nearly all OBM interventions focus on the analysis of behavior of individuals as they work together in groups. Thus, an important consideration is how individuals' behaviors are affected by their social behaviors, or their interactions with one another. Social behavior, most broadly, has been described as "the behavior of two or more people with respect to one another or in concert with respect to a common environment" (Skinner, 1953, p. 297). Skinner (1953) suggested that social behavior is made up of social episodes, or instances where one individual's behavior is affected by another individual's behavior. These interactions between behaviors have also been termed interlocking behavioral contingencies, which are operant contingencies in which the behavior of one individual functions as an antecedent or consequent event for the behavior of another (Glenn, 1988, 2004). Interlocking behavioral contingencies produce an aggregate product, which, when applied at an organizational level, may be considered the goods or services that the organization produces (Camden & Ludwig, 2013). Given that the majority of OBM research involves individuals working together in groups and that interactions between individuals affect the group's aggregate product, social behaviors are an important area for OBM researchers to study.

Taxonomy of social behavior. One difficulty in studying social behaviors is that there is no common taxonomy for categorizing forms of social behavior into formal classes. The terminology used to describe various classes of social behavior varies both between and within academic disciplines that study social interactions.

One behavior analytic approach is offered by Schmitt (1998), who described three elementary forms of social behavior: cooperation, exchange, and competition. Schmitt describes *cooperation* as instances in which a reinforcer is delivered to two or more individuals contingent on all individuals making a response. *Exchange* is similar to cooperation in that both individuals may receive a reinforcer. However, with exchange, two individuals each can engage in a response that provides a reinforcer for the *other* individual. A social interaction is described as exchange once each individual has provided the other with a reinforcer. Finally, Schmitt defines *competition* as an instance in which reinforcers are delivered unequally based on some aspect of each individual's performance (e.g., the individual with the highest score earns the most money). Schmitt's classifications of forms of social behavior are similar to that of other behavior analysts with a few exceptions. For example, Skinner's (1953, 1962) definition of cooperation also includes a specification that one organism plays the role of a leader and the other a follower. Further, several studies (e.g., Hake, Olvera, & Bell, 1975; Hake & Vukelich, 1973) that examined responding under exchange contingencies used the term cooperation when referring to exchange.

Various other terms to classify social behaviors are also used in experimental behavioral science research. Tan and Hackenberg (2016) describe the behavior of rats working under a cooperative contingency for food as *mutualism*, or socially coordinated behavior that produces gains for both animals. Relatedly, West, Griffin, and Gardener (2007) define mutualism as "cooperation between species" and cooperation as "behaviour that provides a benefit to another individual, and the evolution of which has been dependent on its beneficial effect for the recipient" (p. 416). Another classification that may be used to describe a form of social behavior is *altruism* (e.g., Fehr & Gächter, 2002; Jung-Kyoo Choi & Ahn, 2013), defined by West et al. as "a behaviour that is costly to the actor and beneficial to the recipient" (p. 416). Finally, a social arrangement in which individuals share the responsibility of engaging altruistic behaviors, is referred to as reciprocal altruism or reciprocal exchange (e.g., Jimenez & Pietras, 2018).

Given the varied terms used to classify different forms of social behavior, the most precise approach may be to separate it into two broad categories: cooperation and competition. For the remainder of this paper, cooperative behaviors will be defined as behaviors that produce or facilitate the production of reinforcers for one or more members of a group. Whereas, competitive behaviors will be defined as behaviors that produce disproportionate reinforcers in favor of the individual engaging in the behavior at the expense of other individuals in the group. Note that this definition of cooperation includes both cooperation and exchange as defined by Schmitt (1998).

Experimental analyses of human social behavior. Skinner (1953, 1962) provided one of the first demonstrations of a behavior analytic approach to studying social behavior when he reported on instances of shaping cooperative behavior between rats and competitive behavior between pigeons. Following Skinner, several groups of researchers began to conduct experimental analyses of human social behavior. This line of research evaluating social behavior contrasted with the work of many social psychology researchers of the time—who had primarily relied on correlational or interpretive methods—in the level of experimental rigor associated with each type of analysis (Lindsley, 1966). That is, experimental analyses seek to establish functional control over an organism's behavior; whereas, correlational or interpretive methods of analysis only seek to predict behavior (Lindsley, 1966; Sidman, 1960). Where experimental analyses are especially useful in understanding social behavior is that this methodology allows researchers to parse out the separate effects of potential controlling variables in otherwise complex social arrangements. Various methodological approaches have been taken to conduct experimental analyses of social behaviors, and they can generally be categorized into two groups: trial-based decision-making arrangements and free operant arrangements.

Trial-based decision-making arrangements. Traditional approaches to evaluating cooperation and competition amongst humans often involve the use of trial-based choice arrangements, such as the prisoner's dilemma (Axelrod, 1980) or public goods experiments (e.g., Fischbacher, Gächter, & Fehr, 2001; Jones & Rachlin, 2009). With these types of arrangements, all participants on a team are simultaneously presented with a choice between a cooperative response and an alternative, selfish response (or a continuum of alternatives ranging from cooperative to selfish), and once all members of the team have chosen a response option, the results are displayed to the group. Typically, the highest collective payout for the team occurs when all participants choose the cooperative option. However, if one member chooses the selfish option (i.e., defects), that member will receive a higher individual payout while the remaining team members will receive a payout that is lower than if all members had cooperated. For studies evaluating social behavior, this process will then be repeated for successive trials with the same team members.

Marwell and Schmitt (1972) used a prisoner's dilemma arrangement to evaluate the effects of team size on cooperative behavior. Participants were split into groups of two or three individuals, and each group completed 150 trials of the prisoner's dilemma game. Marwell and Schmitt used a traditional prisoner's dilemma game for the dyads and a rationally equivalent version of the game that they modified to be used with the triads. Specifically, each group member chose to either cooperate or defect for each trial. If all group members chose to cooperate, each participant earned $0.08 for that trial. If all group members chose to defect, each participant earned $0.04. If one individual chose to defect and the other group member(s) chose to cooperate, the defecting individual earned $0.12 and the cooperating group member(s) earned $0.00 if in a dyad or $0.04 each if in a triad. Finally, if one member chose to cooperate and the other member(s) choose to defect, the cooperating individual earned $0.00 and the defecting member(s) earned $0.12 if in a dyad and $0.08 each if in a triad.

Marwell and Schmitt (1972) provided participants with instructions on how to play the game as well as the outcome matrix. Next, experimenters seated the participants in separate rooms such that they had no contact with other team members except for when the outcome was displayed to the group. Results indicated that participants working in dyads made cooperative responses more than twice as often as those working in triads, thus suggesting that larger team sizes may have a negative effect on rates of cooperative responding. Notably, this outcome is contradictory to that of a standard economic model which predicts that rates of cooperation would be equal between dyads and triads (due to the use of a rationally equivalent game design). Rather, Marwell and Schmitt (1972) suggest that rates of cooperation were likely lower amongst triads due to a decreased probability that all team members would select the cooperative option at the same time. Thus, there is a decreased likelihood that participants will contact the reinforcement contingencies associated with cooperative responding. However, it is also possible that these results are an artifact of the experimental arrangement, as cooperation is likely a function of the probability that all participants will choose the cooperation response at the same time.

There are other limitations to using iterative choice-based arrangements to measure cooperation. First, arrangements of this nature are trial-based and present an abstract experimental context that is very different from the free-operant nature of employees working in an organization. Second, these arrangements typically have a fixed set of outcomes (a la the outcome matrix). Participants may be more likely to shift responding to find an optimal level of responding; thus, producing a series of fixed patterns of responding. Finally, these arrangements typically involve the restriction of communication between team members. Restricting communication eliminates many of the social aspects (e.g., verbal or nonverbal communication) that are often involved in the shaping and maintenance of social behavior.

Free operant arrangements. To address some of the limitations of trial-based choice arrangements, several methodological approaches have been developed to create a free-operant arrangement. These arrangements allow for more naturalistic simulations of responding over a set period of time—as opposed to a set number of trials. Many approaches for studying human cooperation were adapted from non-human animal methodologies and have evolved along several dimensions. Notably, Hake and Vukelich (1972) outlined four procedural dimensions along which experimental analyses of cooperation may vary: *dependency for reinforcement*, *deviations from reciprocity*, *group members as social stimuli*, and *availability of alternative responses*. In reviewing the published social behavior literature at that time, Hake and Vukelich described each of these dimensions as a continuum along which experimental procedures may be classified.

Dependency for reinforcement. The first area by which cooperation procedures may be categorized is the contingency for reinforcement. On one end, a *dependent contingency* is one where one individual's reinforcers are entirely dependent on another's behavior. For example, Sidowski (1957) paired college students into dyads and gave each student two buttons—one that provided points to a partner and one that delivered a brief shock. On the other extreme of the reinforcement contingency dimension are experiments with an *interdependent reinforcement contingency*, which Hake and Vukelich (1972) describe as "whenever the responses of both individuals are necessary for, or can affect, the reinforcers of one individual" (p. 334). This interdependent contingency was demonstrated by Azrin and Lindsley (1956) in one of the first studies to evaluate cooperative behavior in humans from a behavior analytic perspective.

Using a procedure first developed by Peters and Murphree (1954), Azrin and Lindsley (1956) sat two children on opposite sides of a table with a transparent screen in the middle. Each child was given a stylus that fit into each of three holes at each end of the table. The cooperative response was defined as both children placing their respective stylus into opposite holes within .04 s of each other. Cooperative responses were reinforced with jelly beans provided to both children. Using a reversal design, where cooperation was first reinforced, then placed on extinction, and then reinforced again, Azrin and Lindsley found that cooperative behavior was sensitive to contingencies of reinforcement in the same manner as individual, non-social behaviors.

Deviations from reciprocity. The second dimension along which cooperation procedures may be categorized is the degree to which the experimental preparation controls for reciprocity between participants. Hake and Vukelich (1972) refer to reciprocity as an equal distribution of cooperative responses and reinforcers across all participants. As such, one end of the continuum, *response sharing*, allows for no deviations from reciprocity as both participants are required to engage in the cooperative response in order to receive a reinforcer. The procedures used by Azrin and Lindsley (1956) are an example of response sharing, as the participants were required to engage in the cooperative response at the same time to receive a reinforcer. Thus, the distribution of responses and reinforcers was always equal between the partners. An example of response sharing in the workplace may be if two employees are tasked with unloading and moving objects that are too large to carry alone. In this example, neither individual can complete the task independently, so cooperative responses between the two individuals must be equal.

When a cooperation procedure allows for deviations from reciprocity such that there is an unequal distribution of cooperative responses or reinforcers, that procedure can be classified as *response exchange*. Matthews (1977) developed a method for evaluating cooperation between pairs of individuals when opportunities for unequal response distributions were possible. Pairs of undergraduate students were placed in individual rooms equipped with response panels through which all responses occurred. During each session, participants could freely alternate between working alone and working with their partner by flipping a switch on the response panel. If one or both participants chose to work alone, they could press a button on their response panel to receive $0.02 (with a 10-s timeout period after each button press). If both participants opted to work together, one participant was randomly selected to "get" points first, while the other was selected to "give" points first. Both participant's panels displayed the work context (i.e., independent, give, or get), time remaining in the session, and each participant's earnings for the session. During periods of working together, the participant chosen to give could give the other participant $0.05 per button press (with a 10-s timeout); the receiver's button presses had no effect. The giver could also press an exchange button to swap "give-get" roles at any time. Results indicated that response inequity typically was minimized throughout the session, suggesting that participants were switching roles frequently. When a response cost for switching—both participants lost $0.01 per switch—was implemented some large inequities appeared during sessions, but the inequities were typically reduced by the end of the session. Finally, when the display no longer indicated time remaining, deviations from reciprocity were minimal throughout session.

Partner as a social stimulus. The third dimension along which cooperation procedures may vary is the degree to which a partner may serve as a discriminative stimulus for cooperation.

That is, procedures vary in whether observed behavior is under the control of social versus nonsocial stimuli. On one end of the spectrum, the procedures used by Azrin and Lindsley (1956), where participants sat on opposite ends of a table and could see each other through a translucent screen, represents a *social* arrangement, as each individual's behavior could be directly influenced by the other's behavior.

On the opposite end of the spectrum would be a *nonsocial* arrangement, the most extreme of which could be a situation where participants are completely unaware that they are working as part of a team. For example, Burnstein and Wolff (1964) evaluated the degree to which individuals working in groups were sensitive to various reinforcement contingencies. Burnstein and Wolff placed U.S. Army personnel into teams of three, with each team member in a separate room so they had no knowledge of the group context. Each room was equipped with a response panel that had a response button and a light to indicate reinforcer deliveries. Participants worked under a multiple schedule with different colored lights indicating whether the reinforcement contingency was a differential reinforcement of low- or high-rate behavior (notably, no rules about what the colors indicated were given). These contingencies were collective, such that a single response from any group member contributed to the team's response rate. Results indicated that the teams met the contingency when reinforcers were delivered for short interresponse intervals, but not when long interresponse intervals were reinforced. These results differed from data from two additional participants who completed the procedure individually. These findings suggest that when operating under an individual contingency, participants' responding was sensitive to changes in contingencies without instructions; whereas, under a collective contingency, participants' collective responding was not sensitive to changes in contingencies when no instructions were given and when they did not know they were part of a team.

Hake and Vukelich (1972) stated that the degree to which a partner serves as a social stimulus is an important consideration because these social stimuli may directly affect responding. Specifically, cooperative responding may be influenced by (a) instructions delivered at the beginning of the trial, (b) contingencies of reinforcement, or (c) social stimuli which may function as other antecedent or consequent actions. By providing no rules and removing all sources of social stimuli, Burnstein and Wolff (1964) demonstrated that contingencies alone likely are not responsible for controlling group behavior. As such, cooperation procedures have typically involved informing team members that they are working together. Several variations within this designation may apply. For example, Schmitt and Marwell (1968) placed participants in separate rooms but informed them that they were working with a partner, and Hake and Vukelich (1973) had participants clearly engaging with one another's experimental apparatus. One final area for consideration is whether participants can communicate with one another during the procedure. It is possible that, in a cooperation arrangement, one partner may implement rules for the other to follow that are external to the experimental arrangement and may affect overall responsiveness to contingencies (e.g., Hackenberg & Joker 1994; Miller, Hirst, Kaplan, DiGennaro Reed, & Reed, 2014). Hake and Vukelich provide support for the notion that communication may be an important variable by remarking that "preventing the communication and leadership behaviors in the present study might have affected the degree of reciprocity and the speed of acquisition of cooperative responding" (p. 14). This suggestion, that access to communication increases rates of cooperative behavior, is also consistent with findings of several studies that use trial-based decision-making arrangements to evaluate effects of communication on cooperation (Dawes, 1980, Sally, 1985).

Alternative responses. The final dimension through which Hake and Vukelich (1972) suggest cooperation procedures may be classified is whether an alternative response to cooperation is reinforced. The arrangement initially used for cooperation procedures (Peters & Murphree, 1954; Skinner, 1953, 1962) featured the cooperative response as the only response option that could produce reinforcers. For example, Lindsley (1966) set up an arrangement where two participants could only earn a reinforcer by pulling their respective plungers within 0.5 s of one another.

Hake and Vukelich (1973) demonstrated one of the first approaches to evaluating cooperative responding with an available alterative response. They created an apparatus that involved two identical match-to-sample devices. Each device consisted of a *sample* panel that connected to a *matching* panel. The sample panel had a button which, when pressed, revealed the sample stimulus by illuminating one of three different colored light bulbs for 0.5 s. The matching panel displayed each participant's score and three response keys that corresponded to the three sample lights. Participants were each assigned to one of the devices and earned a point by correctly matching the color displayed on their respective sample panel.

Hake and Vukelich (1973) assigned participants, who were adults with disabilities, into pairs and provided individual training and instructions on how they could earn points, which could later be exchanged for money. Participants were informed that they could press the button on their own sample panel or on their partner's sample panel. Thus, the cooperative response was defined as any time a participant revealed their partner's sample stimulus, and the alternative, or individual, response was defined as any time participants revealed their own sample stimulus. The experimenters manipulated the effort required to emit a cooperative response by changing the distance between sample and matching panels. In the initial condition (*0 m*), participants faced one another 6 m apart with their own matching and sample panels directly in front of them. In this setup, participants could push the button on their own sample panel and respond on the matching panel without moving. In subsequent conditions, the experimenters moved the sample panels further away from their respective matching panels and closer to the partner's matching panel. In the *3-m* condition, the two sample panels were both at the midpoint between the two participants (the sample panel light always faced its respective matching panel). Finally, in the *6-m* condition, each participant's sample panel was adjacent to their partner's matching panel. In sum, participants were provided with two response options: a cooperative response where participants revealed their partner's sample stimulus and an alternative response where participants revealed their own sample stimulus.

To evaluate if allocation of responding to the alternative response was sensitive to an antecedent manipulation, Hake and Vukelich (1973) manipulated the response effort required to engage in each response. Results demonstrated that all pairs engaged in more cooperative responses than individual responses during the 0-m condition (highest effort for cooperation). During the 3-m condition, the majority of participants allocated most of their responding to the individual response, although some pairs engaged in more cooperative responses than individual responses. Most participants favored the cooperative response during the 4.5-m condition, and all participants favored the cooperative response in the 6-m condition (lowest effort for cooperation). Thus, Hake and Vukelich's (1973) results were consistent with several other studies demonstrating that response allocation toward a cooperative versus alternative response was sensitive to antecedent or consequent experimental manipulations (e.g., Marwell, Schmitt, & Shotola, 1971; Mithaug, 1969; Shimoff & Matthews, 1975).

Limitations of free operant arrangements. Although consistent effects of experimental manipulations on allocation of responding between cooperative and alternative responses have been found, there are some limitations in the generality of these findings. In the extant literature, only a few levels of independent variables are evaluated in any given study. Thus, we are limited in the degree to which patterns of responding may be used to develop a more thorough conceptual understanding of the parameters of variables that control social behavior.

Social behavior and discounting. One area of research—delay discounting—has conducted a more comprehensive analysis of social behavior using trial-based decision-making arrangements. These iterative choice arrangements typically offer a more standardized approach than free operant methods, thus allowing for more analytic flexibility. Several recent studies have evaluated the relation between participants' choice to cooperate in a prisoner's dilemma game and their rate of delay discounting—the rate at which individuals discount monetary rewards as a function of increasing delay to its receipt (Harris & Madden, 2002; Yi, Buchhalter, Gatchalian, & Bickel, 2007; Yi, Johnson, & Bickel, 2005).

For example, Yi, Johnson, & Bickel (2005) evaluated participants' responding on a prisoner's dilemma game when playing with a computer that simulated team members' responses. The computer selected the option to cooperate or defect either randomly or using a tit-for-tat strategy, where the computer selects the same decision that the partner made on the previous trial. Yi et al. found that participants who chose the cooperative option more often during the tit-for-tat condition had lower rates of delay discounting than those who chose to defect more. In addition, discounting rates were not correlated with response rates during the random selection condition, suggesting that participants who discounted rewards less were more sensitive to contingencies on their own behavior. Findings from this line of research are promising as they suggest that discounting research and, more broadly, research in the area of behavioral economics may be an effective approach toward increasing the generality and conceptual foundation of research findings on social behavior.

Behavioral Economics

Behavioral economics[1] is a subfield of behavior analysis that integrates principles from microeconomics and behavior analysis to better understand patterns of human choice (Hursh 1980, 1984). The incorporation and use of behavioral economic principles has helped produce gains in a range of areas of societal importance, including treatment of problem behavior exhibited by individuals with intellectual and developmental disabilities (Gilroy, Kaplan, & Leader, 2018), education (e.g., Neef, Shade, & Miller, 1994), informing public policy (e.g., Hursh & Roma, 2013), assessing risky sexual behavior (e.g., Johnson & Bruner, 2012), treating drug and alcohol abuse (e.g., Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014), gambling (e.g., Dixon, Marley, & Jacobs, 2003), and other potentially harmful behaviors (e.g., Becirevic, Reed, & Amlung, 2017, Lappalainen & Epstein, 1990). Recently, several researchers have suggested that various areas of OBM research could benefit from the application of behavioral economic principles (e.g., Jarmolowicz, Reed, DiGennaro Reed, & Bickel, 2016; Roma, Reed, DiGennaro Reed, & Hursh, 2017; Sigurdsson, Taylor, & Wirth, 2013; Wine, Gilroy, & Hantula, 2012).

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[1] The term *behavioral economics* covers a broad range of disciplines (e.g., economics, cognitive psychology, neuroscience, behavior analysis) focused on accounting for irrational behavior, and the goals and theoretical and conceptual approaches used varies across these disciplines (Madden, 2000). Behavioral economics as it is discussed in this paper is from a behavior analytic perspective.

Demand curve analyses. One area of behavioral economics that may be useful for OBM researchers is the law of demand, which states that a commodity's relative consumption will decrease when constraints, such as price of the commodity, increase (Samuelson & Nordhaus, 2009). Demand curve analyses are a parametric approach to measuring and evaluating consumption of a commodity across a range of prices. When graphed, a prototypical demand curve (e.g., Figure 1) plots consumption along the y-axis, prices along the x-axis, and a curve is fit to the data. In accordance with the law of demand, consumption will decrease as prices increase. Decreases in consumption are defined by two portions of the demand curve, inelastic and elastic demand. *Inelastic demand* refers to the portion of the curve at relatively lower prices, where increases in price produce minimal decreases in consumption. *Elastic demand* is defined by the portion of the curve where increases in price produce proportionally greater decreases in consumption. Key metrics can be derived from demand curve analyses that provide measures of reinforcing efficacy and allow for quantitative comparisons across commodities. Thus, demand curve analyses allow for extensive study of parameters that affect a single commodity as well as comparisons across commodities.

Experimenters have utilized demand curve analyses to assess a range of commodities in human operant settings (e.g., Bickel & Madden, 1999) and with hypothetical arrangements (Jacobs & Bickel, 1999). For example, Bickel and Madden (1999) evaluated relative reinforcing efficacy of cigarette puffs and money for four adult smokers. The participants could pull plungers to earn three cigarette puffs or $0.20, and the number of responses required to earn each reinforcer increased across days. The two reinforcers were first evaluated independently, and demand curves were fit to data on the number of reinforcers earned for the two commodities at each price. Derived measures of reinforcing efficacy from demand curves were predictive of participants' preference for the reinforcers when they were presented concurrently at various prices, thus demonstrating the utility of demand curves as a measure of reinforcing efficacy.

Jacobs and Bickel (1999) introduced a hypothetical purchase task (HPT), which extended the domains to which demand curves analyses can be applied. The HPT involves evaluation of self-reported consumption of a given commodity when presented with a vignette outlining key contextual factors (e.g., presence or absence of potential consequences, availability of other commodities, timeframe within which commodities must be used). Jacobs and Bickel observed systematic decreases in consumption as a function of increasing price that were consistent with human operant experiments. Subsequent research has directly evaluated HPT validity (e.g., Amlung & MacKillop, 2015) and has found high correspondence between self-reported and observed consumption. Because minimal risks, decreased time, and increased logistical feasibility are associated with administering HPTs, researchers have been able to assess a wider range of commodities than previously possible with human operant studies (e.g., Roma, Hursh, & Hudja, 2015).

Several different mathematical methods have been used to quantify demand data (e.g., Hursh, Raslear, Bauman, & Black, 1989; Koffarnus, Franck, Stein, & Bickel, 2015; Yu, Liu, Collins, Vincent, & Epstein, 2014). However, Hursh and Silberberg's (2008) exponential model of demand is used often in contemporary research and will be the model discussed for the remainder of the paper.

Behavioral economics in OBM. When applying a behavioral economic framework to behavior in work settings, an incentive may be considered a commodity and its price may be the amount of work required to earn it. In two recent studies, Henley and colleagues examined this framework by applying demand curve analyses to work performance. Henley, DiGennaro Reed, Kaplan, and Reed (2016) used a hypothetical work task—an adaptation of the HPT—to ask participants to indicate the likelihood they would pass out an increasing number of flyers for a $10 incentive. Participants completed the survey under two conditions that varied in delay to payment (1 hour or 4 weeks). Results indicated that demand was more elastic—participants were more sensitive to increases in response requirements—under the longer delay condition, a finding consistent with prior demand analyses evaluating the effect of delay (e.g., Hursh, 2014).

In a second study, Henley, DiGennaro Reed, Reed, and Kaplan (2016) conducted a human operant experiment to assess sensitivity to increasing work requirements in a more naturalistic work setting. Participants were employees of an online work platform (Amazon Mechanical Turk) who completed increasing amounts of analog work tasks for small monetary incentives ($0.05 or $0.10). Demand curve analyses on workplace survival (i.e., the percentage of employees who were willing to complete the task at a given response requirement) demonstrated systematic decreases as work requirements increased, consistent with the extant literature involving demand curve analyses.

These findings are promising as they lend support to the utility of applying a behavioral economic framework to improve performance in organizational settings. For example, Henley, DiGennaro Reed, Reed, et al. (2016) demonstrated a method for assessing a workplace as a single unit by measuring employee survival at each response requirement. Further, an employer could follow the methodology used by Henley, DiGennaro Reed, Kaplan, et al. (2016) to assess how delays to incentive delivery lead to decreases in optimal performance.

Demand and social behavior. Recently, Hursh and Roma (2013) demonstrated an extension of demand curve methodology to the study of social behavior. Participants working in teams of three played a computer-based game for monetary rewards. The game (named the

Team Performance Task; Emurian et al., 2011) created situations where participants were presented with a choice between scoring points for themselves or helping their teammates score points via a cooperative response. Because cooperation and point scoring were mutually exclusive, Hursh and Roma conceptualized the time required to complete a cooperative response as a price of cooperation, where the price for cooperating was the opportunity cost of time that could have been spent scoring points. The price of cooperation changed within each experimental trial, and participants completed a series of trials under various incentive conditions. Cooperative responses at each price were examined using demand curve analyses. Results indicated that cooperative responses were sensitive to increases in price of cooperation in a manner consistent with demand curve analyses for other more commodities. These findings provide support for the use of demand curve methodology in conducting parametric analyses of social behavior.

Purpose

Despite the prevalent use of incentives in performance management interventions, our understanding of the differential effects of the contexts in which they are used is limited. One key context, and the focus of this paper, is on the use of incentives with teams or groups of individuals working together; specifically, on the relation between incentive arrangements and cooperative behavior amongst teammates. Although there is a considerable amount of literature on both group incentives and social behavior, this research has predominantly evaluated the two areas independently—and mostly by researchers working in separate domains of behavior analysis.

In the present study I sought to synthesize literature on cooperation and group-based incentives within a behavioral economic framework. For my experimental arrangement, I used a second generation of Hursh and Roma's (2013) Team Performance Task, a program named COHESION (Capturing Objective Human Econometric Social Interactions in Organizations and Networks). A second aim of the present study was to assess the utility of the COHESION program for evaluations of variables that commonly affect workplace performance. Experiment 1 provided an evaluation of the COHESION program and associated methodology. I assessed performance under different levels of a variety of potential controlling variables: (a) level of restriction of communication within teams, (b) probability of incentive delivery, and (c) incentive type. Experiment 2 extended findings from Experiment 1 using a similar framework, but with a focus on restriction of communication and incentive type. In addition, I used demand curve analyses to evaluate sensitivity to increases in cooperative response requirement under each experimental condition.

Experiment 1

Method

The purpose of Experiment 1 was to conduct a systematic replication and extension of Hursh and Roma's (2013) methodology using the COHESION program. The extension components included assessments of the effects of communication restriction and probability of incentive delivery.

Participants and setting. Participants for Experiment 1 were six female undergraduate students who were recruited from introductory courses in applied behavior analysis offered at a large Midwestern university. Participants were recruited via in-class announcements—the script used for recruitment announcements is provided in Appendix A. All methods for the experiment were approved by the university's human subjects committee prior to recruitment. Participants were assigned to two teams—in the order in which they signed up for the experiment—with three participants in each team. Participants were paid $10.00 plus any monetary incentives earned throughout the experimental session as compensation. Compensation was delivered through the ClinCard program, a system that allows experimenters to make payments to participants through a rechargeable credit card.

Data collection for each team occurred within a single 90-min visit, and the two teams participated on separate days within a 2-week time frame. All sessions took place in a 4.6 by 5.7-m room located on the university's campus. The layout of the room is shown in Appendix B. Two participants were seated on one side of the table, with the third participant on the opposite side. All participants faced the center of the table, and the experimenter sat facing the three participants at the head of the tables.

COHESION program, gameplay, and apparatus. The COHESION program used for the experiment is a networked web application that operates over the Internet or a closed intranet and is designed to function across most devices (e.g., desktops, tablets, laptops), operating systems (i.e., Windows, macOS), and modern web browsers (e.g., Chrome, Safari, Firefox). The COHESION server was written with the Ruby programming language (www.ruby-lang.org) and uses the Ruby on Rails framework (rubyonrails.org).

Appendix C displays an annotated interface presented to participants during gameplay. All engagement took place within the square game board in the middle of the screen, and teammates simultaneously played using separate computers. During gameplay, square boxes (resources) appeared one at a time in a random location along the outside of the square game board. Participants could score points by using their mouse to click on a resource and drag it into the target square in the middle of the screen. Participants earned one point for each resource that they moved to the target zone—a single resource was always available for each participant.

A score panel on the top left side of the screen displayed participants' score (in points) for the trial. Several barriers were randomly dispersed throughout the field, and if a resource made contact with a barrier, one point was deducted from the score. Each team member had three barriers that only he or she could see, but all team members would lose points if they struck an invisible barrier with a resource. That is, there were always nine barriers, and any group member could lose points for colliding a resource with a barrier whether it was visible or not. Each team members' barrier reveals were in random locations on team members' game board.

Each barrier had a lifespan of 10-15 s and, at the end of the lifespan, it would move to a new, randomly determined location. An individual could reveal a barrier to other members of the team by clicking their mouse on a barrier and holding it for a given duration. When participants start to reveal a barrier, a small yellow line appears and begins to form a circle around the outside of the barrier as an indication of how much time remains until it is revealed. Once revealed, a barrier was visible to all members of the team for the remainder of its lifespan; barriers returned to being invisible when moving positions at the end of a lifespan. (Note that barrier reveals did not add time to the lifespan. So, if a barrier reveal occurred near the end of its lifespan, it may only be visible to team members for a short duration.)

Participants were each seated at a Microsoft Surface 3 tablet running Windows 10, and they accessed the COHESION program through an individualized link that was opened in Google Chrome (versions 52.0-53.0). All interactions with the program took place through use of an attached, wired computer mouse (Microsoft Basic Optical Mouse v2.0) which was placed on a 21.5 by 19.5-cm mousepad. The COHESION server was hosted on a Dell desktop computer running Windows 10, and all computers connected to the server via the university's wireless Internet.

Dependent variables. I evaluated responding on two dependent measures, barrier reveals and score. The COHESION program automatically collected data on both variables and saved data for each session in a single comma-separated values delimited text file.

Barrier reveals. My primary measure of interest was the frequency with which participants revealed barriers (i.e., barrier reveals). A barrier reveal was scored when participants clicked on an unrevealed barrier and held down the mouse until it was made visible to their teammates. Any incomplete attempts to reveal a barrier (e.g., participant stopped holding the mouse, barrier changed locations) and interactions with already-revealed barriers were not classified as barrier reveals. Barrier reveal totals were calculated as number of barriers revealed per 30-s segment and per 3-min trial. Because the act of revealing a barrier was hypothesized to help teammates avoid barrier collisions, barrier reveals were conceptualized as a measure of cooperative responding.

Score. To assess the effects of the experimental manipulations on overall performance, I also examined net score data. Net score was calculated as the number of points scored per 3-min trial or per 30-s segment minus the number of points lost during the same time frame. Score was conceptualized as a measure of productivity.

Independent variables and design. I measured cooperation (i.e., barrier reveals) and productivity (i.e., score) as a function of four independent variables: communication, incentive type, incentive probability, and price of cooperation. Effects of communication restriction were assessed between the two teams. I also tested for differential within-team response patterns that may have been due to incentive type and incentive probability manipulations. Finally, manipulations in the price of cooperation occurred within all experimental trials.

Communication. The arrangement for the two teams differed in the degree to which team members could communicate with one another. The first team to participate, referred to as the *unrestricted* team, was assigned to the unrestricted communication condition. Immediately prior to the first trial, the experimenter told them, “You may feel free to talk amongst yourselves throughout the session.” The second team, referred to as the *restricted* team was assigned to the restricted communication condition. Immediately prior to the first trial, the experimenter told them, “You may not talk amongst yourselves while you are playing the game. In between trials, you are free to talk about topics that are not related to the game.” If participants on the restricted team spoke during a trial, or spoke about the game between trials, the experimenter reminded participants of the rules stated at the beginning—this prompt was not required at any point in Experiment 1.

Incentive type. I evaluated the effects of three incentive types: individual, collective, and fixed incentives. Incentive types were arranged in the same manner as those examined by Hursh and Roma (2013) and were explained to participants at the beginning of each trial. In the *individual* incentive condition, participants earned $0.10 per point for their net score on the preceding trial. In the *collective* incentive condition, a team’s net score for the trial was totaled, exchanged for $0.10 per point, and then divided equally amongst the three teammates. In the *fixed* incentive condition, each team member earned $1.00 for the trial independent of their performance—this fixed amount was set to simulate a wage of $20 per hour. Thus, all participants earned the same amount as their teammates during the collective and fixed conditions.

Probability of incentive delivery. The probability that an incentive would be delivered following each trial varied across trials. I assessed performance under *10%* and *100%* incentive probabilities. Incentive probabilities were determined by rolling a 20-sided die, and incentives were delivered if the resulting die roll fell within a predetermined range. That range was 1-2 for the 10% condition and 1-20 for the 100% condition—thus, the incentive was always delivered during 100% probability trials.

I assessed whether obtained probabilities of incentive delivery differed from programmed probabilities for each team by dividing the number of trials in the 10% condition that a team received an incentive by the total number of trials in the 10% incentive condition. Both teams received the incentive on one out of nine trials (11.11%) in the 10% condition. The trial that the restricted team received the incentive for was in the fixed condition, and the unrestricted team received the incentive for a trial in the individual condition. Both teams received the incentive on their first exposure to a trial in the 10% condition.

Both teams were exposed to all combinations of incentive type and probability, a total of six incentive conditions delivered across 18 trials. To determine the order of the incentive conditions, I first grouped trials into blocks of three and assigned the 100% and 10% probabilities to each block in an alternating fashion, starting with 100%. I assigned each of the three incentive types to one trial per block in a randomized order using a random number generator written in Visual Basic for Applications in Microsoft Excel. Appendix D shows trial orders for both teams.

Price of cooperation. To assess sensitivity to changes in price of cooperation, I arranged the COHESION program to change the time required to reveal a barrier during gameplay. This manipulation occurred within each trial, across six 30-s segments in an ascending fashion in the following order (in seconds): 0.25, 0.5, 1, 2, 3, 4. Thus, the duration required to reveal a barrier increased systematically throughout each trial and reset back to 0.25 s at the beginning of each subsequent trial. Barrier reveal duration was conceptualized as a *price of cooperation* from the standpoint that the duration required to reveal a barrier was time that could not be spent scoring points.

Procedure. Upon arrival, an experimenter greeted participants, provided them with an informed consent form (Appendix E) and brief demographic questionnaire (Appendix F) to complete, and registered them for the ClinCard program. Participants were then instructed to sit at the computer number that corresponded to the order in which they arrived (as shown in Appendix B).

Prior to the first trial, the experimenter gave participants an information sheet (Appendix G) with an annotated diagram of the game board and a description of the incentive types and probabilities. Attached to the information sheet was a tracking log that outlined the trial order and had a space for participants to record their earnings (Appendix H). The experimenter explained the COHESION gameplay, detailing the point system, how to reveal barriers, and that participants would be working together to score points. Next, the experimenter explained the three incentive types and two incentive probabilities. Description of the game and incentive arrangement lasted no more than 5 min. Participants then had the opportunity to practice in one 90-s training trial while the experimenter observed each team member to ensure proficiency. (Note that, due to a procedural error, the restricted team experienced two 90-s practice trials.) Following the practice trial, participants had the opportunity to ask any questions. Finally, the experimenter answered any questions, stated the instruction outlining each team's level of communication restriction, and moved to the start of the first trial.

All trials were 180 s in duration, with an approximately 90-s intertrial interval. The experimenter stated the incentive type and probability prior to the start of each trial and again immediately after the trial. During the intertrial interval, the experimenter restated the necessary range to receive the incentive, rolled the die, and announced the result. The experimenter then informed each team member of his or her earnings for that trial (if the die roll determined that no incentive would be delivered, the experimenter stated that the participants earned $0.00 for that trial) and moved to the start of the next trial.

At the end of the last trial, the experimenter asked the subjects to complete a short debrief questionnaire (Appendix I) that asked questions about the clarity of the COHESION gameplay instructions, clarity of the incentive instructions, participants' experience with the COHESION gameplay, and whether participants had any sources of outside income. Finally, the experimenter totaled the participants' earnings and gave each a note indicating how much money they earned for the session. Participants' earnings were added to their ClinCards within 48 hours of their date of participation.

Data analysis. I conducted all analyses at the team level, such that the team's barrier reveal total and net score were determined by taking the sum of all three team members' responses. I analyzed data by (a) comparing response totals across trials and (b) examining responding within trials using demand curve analyses.

Trial aggregates. I conducted a series of nonparametric tests to determine whether the two primary dependent variables, barrier reveals and score, were differentially affected by communication restriction, incentive probability, or incentive type. I used a Mann-Whitney test to examine if there were any differential effects due to the communication manipulation; the same test was used to examine responding under the 10% versus 100% probability conditions. I conducted a Kruskal-Wallis one-way ANOVA to test for differential effects across the three incentive type conditions and, if significant differences were calculated, a Dunn's multiple comparison post-test to determine if there were any pairwise differences between the conditions. I calculated effect sizes using the Psychometrica online calculator for non-parametric tests (Lenhard & Lenhard, 2016), which uses calculations recommended by Fritz, Morris, and Richler (2012) and Cohen (2008). All other statistical tests and model fits were conducted using GraphPad Prism® 8.00 (131) for macOS (GraphPad Software, La Jolla, CA, USA, www.graphpad.com). Finally, all analyses for Experiment 1 were two-tailed.

My decision to use nonparametric tests was due to violations of the assumptions of parametric analyses (Siegel, 1956) inherent in the experimental design. Primarily, the experimental design did not support the assumption of independent samples. Measurements were taken as a series of trials within each condition, and as such, each measure is partially influenced by the team's previous experience with the same—as well as different—conditions. This serial dependency suggests that repeated measures cannot be considered independent from one another (Johnston & Pennypacker, 2009; Jones, Weinrott, & Vaught, 1978). A second reason is that descriptive analyses revealed large differences in variance across samples. Finally, D'Agostino-Pearson normality tests and visual inspection of the data suggested that several samples had non-normal distributions of data.

Demand curve analyses. To assess sensitivity to increasing prices of cooperation, I fit the teams' barrier reveal totals at each price of cooperation (i.e., each 30-s segment) to Hursh and Silberberg's (2008) exponential model of demand equation:

$$logQ = logQ_0 + k(e^{-\alpha(Q_0 \cdot C)} - 1) \quad (1)$$

where Q is consumption (barrier reveals) and C is cost (price of cooperation). Alpha (α) represents change in elasticity—or the rate at which consumption is sensitive to increases in price—across the range of prices. Intensity of demand is represented by Q_0, which is equal to consumption when the price is free. Finally, the scaling constant *k* represents the range of consumption in log units.

I fit the data to Equation 1 using a freely available GraphPad Prism® template provided by the Institutes for Behavior Resources (Exponential Model of Demand template; www.ibrinc.org). For all demand analyses, Q_0 and α were left unconstrained and *k* was set to equal log range consumption plus 0.5. This method of determining the *k* was chosen to account for the potential of levels of consumption higher than those observed (Gilroy, Kaplan, Reed, Koffarnus, & Hantula, 2018). I fit demand curves to data from each combination of communication condition, incentive type, and incentive probability (e.g., unrestricted-10%-fixed incentive)—a total of 12 curves. The log range of consumption in Experiment 1 was 2.0, so *k* was set at 2.5 for all analyses.

I derived the additional demand metrics, P_{max} and essential value (*EV*), from Equation 1 using a freely available Microsoft Excel-based calculator developed by Kaplan and Reed (2014) that uses equations for each metric presented by Hursh (2014). P_{max} indicates the price at which consumption shifts from inelastic to elastic and is calculated with Equation 2:

$$P_{max} = \frac{m}{Q_0 \cdot \alpha \cdot k}, \text{ where } m = 0.083k + .65. \quad (2)$$

Essential value, like α, reflects sensitivity to changes in price and is calculated with Equation 3:

$$EV = \frac{1}{100 \cdot \alpha \cdot k^{1.5}}. \quad (3)$$

I conducted a series of Extra sum-of-squares *F* tests to determine if one curve adequately fit multiple data sets. I compared values across the three incentive types for all four combinations of communication and probability conditions (i.e., restricted-10%, restricted-100%, unrestricted-10%, and unrestricted-100%).

Results and Discussion

Demographic and debrief data. Demographic characteristics for participants in Experiment 1 are depicted in Table 1. Participants' ages ranged from 18-20 years ($M = 19$). Team compositions with respect to demographic characteristics are detailed in Table 2 along with participants' incentive earnings for the session.

Results from the debrief questionnaire indicated that all participants found the COHESION instructions to be moderately clear or very clear. Similarly, all participants found instructions about how incentives were to be delivered to be moderately clear or very clear. All six participants indicated that they have outside sources of income: five indicated that they have a job (all of whom also have loans or receive financial assistance from parents or guardians) and the sixth also received student loans.

Group aggregates. Tables 3-5 depict aggregate trial totals for barrier reveals and score when separated out across team, probability of incentive delivery, and incentive type.

Communication. Trial totals for barrier reveals and score separated out between the restricted and unrestricted teams are depicted in Figure 2. A Mann-Whitney test indicated there was a significant difference in barrier reveals ($Mdn_{\text{Unrestricted}} = 77.5$, 95% CI [74, 87]; $Mdn_{\text{Restricted}} = 10.5$, 95% CI [5, 38]) between the two teams, $U = 10$, $p < .001$, $d = 2.68$, with the unrestricted team ($Mdn = 113.5$, 95% CI [104, 124]) also scoring significantly more points than the restricted team ($Mdn = 84$, 95% CI [71, 93]), $U = 32$, $p < .001$, $d = 1.88$.

Probability of incentive delivery. Given the large differences in responding between the two teams, I evaluated effects of probability of incentive delivery for each team separately.

Figure 3 and Table 4 depict trial totals for barrier reveals and score between probability of incentive delivery conditions for both teams. Mann-Whitney tests indicated no statistically significant difference in barrier reveals between probabilities for the restricted, $U = 19.5$, $p = .066$, $d = 0.97$, or unrestricted teams, $U = 36$, $p = .715$, $d = 0.19$. There was also no indication of a difference in score between probability conditions for the restricted, $U = 19.5$, $p = .065$, $d = 0.97$, or unrestricted teams, $U = 37.5$, $p = .812$, $d = 0.13$.

Incentive type. As I did with evaluations of probability of incentive delivery, I evaluated effects of incentive type for each team separately. Each team's trial totals for barrier reveals and score separated out by incentive type are depicted in Figure 4 and Table 5. Kruskal-Wallis one-way ANOVAs showed that there was no significant difference in barrier reveals for the restricted, $H(2) = 1.5$, $p = .489$, $\eta^2 = 0.033$, and unrestricted teams, $H(2) = 1.96$, $p = .394$, $\eta^2 = 0.107$. Likewise, Kruskal-Wallis tests found no significant difference in scores between the incentive types for the restricted, $H(2) = 1.67$, $p = .453$, $\eta^2 = .103$, and unrestricted teams, $H(2) = 1.25$, $p = .558$, $\eta^2 = .096$. Follow-up Dunn's multiple-comparisons tests were not conducted given that the ANOVAs did not reveal significant differences.

Price of cooperation. Mean barrier reveal rates across the range of prices of cooperation separated out by team and probability of incentive delivery are depicted in Figures 5-7. Demand parameters and indices for each curve are listed in Table 6. Overall, these data indicate systematic decreases in barrier reveal rates as a function of increasing price of cooperation for all analyses; however, given the limited number of exposures to each condition combination, there are some exceptions. For example, in the individual-10% condition, the restricted team revealed more barriers when the price of cooperation was 2 s ($M = 3.33$ reveals) than at the 0.5 and 1 s prices of cooperation (Ms = 2.67 and 2.33 reveals, respectively). The restricted team's responding in the fixed-10% condition is also worth noting as the mean barrier reveal rates at three prices (0.25, 3, and 4 s) was 0. Because the exponential demand equation requires logarithmic transformation of data (and the logarithm of 0 is undefined), these values were not analyzed[2]. Given the limited data available to generate each curve, I restricted the scope of these analyses to examination of broad patterns across conditions, rather than close inspection of individual parameters and demand metrics.

Figure 5 depicts the restricted team's data for each incentive type separated across the 10% (top panel) and 100% (bottom panel) probability of incentive conditions. As mentioned above, the limited number of exposures at each price of cooperation produced somewhat unsystematic visual response patterns in the 10% probability conditions and relatively poor fits to the exponential demand equation (R^2s = .83, .04, and .61 for collective, individual, and fixed conditions, respectively). An Extra sum-of-squares *F* test confirmed that there was a significant difference between the curves, $F(4,9) = 13$, $p < .001$.

Data for the restricted team appeared to be more systematic in the 100% probability conditions and provided better fits to the exponential demand equation (R^2s = .92, .91, and .84 for collective, fixed, and individual conditions, respectively) than the 10% conditions. Responding was most elastic under the collective condition ($\alpha = .011$) and least elastic under the individual condition ($\alpha = .005$), indicating that responding was most sensitive to increases in price of cooperation under the collective condition. An Extra sum-of-squares *F* test indicated that a single curve does not fit the data from all three incentive types, $F(4,12) = 5.1$, $p = .013$.

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[2] A total of 5 zero-values were not analyzed. The remaining two were under the unrestricted-100%-collective and unrestricted-10%-individual conditions at the 4-s price of cooperation.

Demand curves for the unrestricted team are depicted in Figure 6 and are separated by incentive type between the 10% (top panel) and 100% (bottom panel) conditions. Extra sum-of-squares *F* tests indicated that one curve adequately fit the data from all three incentive types for the 10% probability condition, $F(4,11) = 0.07$, $p = .991$, and, separately, the 100% probability condition, $F(4,11) = 1.4$, $p = .291$. As such, these data are depicted by the single shared curve that best fits all data under each probability condition. I conducted an additional test to examine if all the unrestricted team's data could be adequately fit with a single curve. Results indicated that a single curve adequately fit all of the unrestricted team's data across all incentive types and probabilities, $F(10,22) = 0.81$, $p = .624$. The shared aggregate curve is shown in Figure 7 and demand parameters and metrics are outlined in Table 6.

To summarize findings from Experiment 1, I observed large differences in aggregate barrier reveals and score attributable to the communication manipulation. The unrestricted team engaged in more cooperative responses and scored more points than the restricted team. However, patterns of differentiated responding were not present when evaluating incentive delivery manipulations. I observed no significant differences attributable to either probability of incentive delivery or incentive type.

Demand curve analyses of within-session cooperative responding demonstrated systematic decreases in responding as a function of increasing price of cooperation. Closer examination of responding across each of the independent variables revealed two different response patterns between the two teams. The unrestricted team's cooperative responses across all conditions were accounted for by a single demand curve. That is, there were no significant differences in intensity or elasticity of demand between any of the incentive probabilities or types. In contrast to the unrestricted team's uniform responding, the restricted team's cooperative responses varied greatly across incentive conditions. For example, at low prices, they revealed the fewest barriers under the individual condition, but when prices increased, they revealed the most barriers in the individual conditions. Thus, analyses of responding across a range of prices revealed differences between incentive type conditions that were not detected at the aggregate level.

Taken together, the findings from Experiment 1 demonstrated the utility of a methodological framework involving COHESION to assess the effects of different independent variables. However, given that the nature of Experiment 1 was as an initial investigation, the generality of findings is limited for several reasons. With respect to the communication manipulation, no data were collected on the teams' verbal behaviors during sessions to provide validity to the different levels of the independent variable—anecdotally, the restricted team did not communicate with one another and the unrestricted team communicated continuously throughout the session. In addition, only one team participated in each condition, so the observed effects may have been idiosyncratic. Analyses of incentive type and probability outcomes are also limited due to the low frequency of exposures to each incentive condition. Because there were few trials under each incentive type and probability combination, it was difficult to isolate effects on any single controlling variable. Thus, the focus of Experiment 2 was to lend generality to these findings by focusing on fewer experimental conditions with more teams.

Experiment 2

Method

In Experiment 2, I addressed the limitations identified in Experiment 1 and extended the generality of its findings. I used a similar arrangement as in Experiment 1 but removed the collective incentive condition and the probability of incentive delivery independent variable. These manipulations allowed for twice as many exposures to each incentive type as were possible in Experiment 1. Thus, my research question focused on the effects of fixed versus individual incentives on cooperation and productivity amongst restricted versus unrestricted communication teams. I also increased the number of teams in each condition to account for potentially idiosyncratic effects between communication conditions.

Participants and setting. The participants for Experiment 2 were 24 undergraduate students (3 males and 21 females) recruited in the same manner as in Experiment 1. Participants were assigned to teams in the order in which they signed up for the experiment, with three participants in each team. Participants were compensated in the same manner as Experiment 1.

Data collection for each team occurred within a single 90-min visit, and teams participated within a time frame of 47 weeks. All sessions took place in the same room, with the same arrangement, as Experiment 1.

COHESION program, gameplay, and apparatus. The materials were the same as in Experiment 1 with the following exceptions. First, the program was run on Google Chrome (versions 54.0-61.0). Second, for the first four teams to participate, the COHESION server was run on a Dell desktop computer running Windows 10 and all computers were connected through the university's wireless internet (the same setup as in Experiment 1). Whereas, for the last four teams to participate, the COHESION server was run on a MacBook Pro running macOS version 10.12 and all computers were connected through an Ethernet-connected local area network. These changes to the apparatus were made to improve the stability of the program (previously any disruption in connection would effectively terminate the session in progress[3]). To my knowledge, there were no differential effects to gameplay as a result of these changes.

Dependent variables. The primary dependent variables were barrier reveals and score and they were measured in the same manner as with Experiment 1.

Independent variables and design. I measured cooperation (i.e., barrier reveals) and productivity (i.e., score) as a function of three independent variables: communication restriction, incentive type, and price of cooperation. As in Experiment 1, communication restriction was assessed between groups, incentive type was assessed within group, and price of cooperation was assessed within each trial.

Communication. Communication restriction was arranged using the same conditions as in Experiment 1. The first four teams to participate were assigned to the restricted communication conditions and will be referred to as R_1, R_2, R_3, and R_4. The final four teams to participate were assigned to the unrestricted communication condition and will be referred to as UR_1, UR_2, UR_3, and UR_4. The experimenter used the same instructions and procedure to implement the conditions as in Experiment 1.

Incentive type. I evaluated effects of the fixed and individual incentive conditions, which were arranged in the same manner as in Experiment 1.

Price of cooperation. Barrier reveal durations were arranged in the same manner as with Experiment 1.

Procedure. As with Experiment 1, participants had the opportunity to earn an incentive following each 180-s trial. Incentive type for each trial alternated in a quasi-random order such

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[3] Participants for whom connectivity issues occurred were dropped from the experiment. All data reported are from participants' first experience with the COHESION program.

that no incentive type was presented more than two consecutive times and the difference between frequency of presentations for each incentive was no greater than one. Trial orders were randomized using the same random number generator as in Experiment 1 and are listed in Appendix J.

The same procedures as Experiment 1 were used for participant orientation and instructions. The experimenter restated incentive type and informed each team member of his or her earnings during the intertrial interval, which took approximately 90 s. As with Experiment 1, the experimenter totaled participants earnings at the end of the last trial, gave each participant a note indicating how much they earned for the session, and added money to the ClinCards within 48 hours. Participants did not complete a debrief questionnaire for Experiment 2.

Data analysis. As in Experiment 1, I conducted all analyses at the team level and evaluated responding across and within trials. All analyses were the same as with Experiment 1 with the following exceptions. First, because there were only two incentive type conditions (individual and fixed), I used a Mann-Whitney instead of a Kruskal-Wallis to measure its effects. Second, I conducted demand curve analyses to assess differences between communication conditions, between incentive conditions, and between each of the four combinations of communication and incentive conditions. Likewise, I conducted a series of Extra sum-of-squares *F* tests to determine if one curve adequately fit all the data sets across communication conditions, incentive conditions, and the combined communication and incentive conditions. The scaling parameter, *k*, was 1.4 for the communication curves (log range: 0.9), 1.9 for the incentive type curves (log range: 1.4), and 2.7 for the combined communication and incentive curves (log range: 2.2).

Procedural integrity. Data on the experimenter's implementation of the experimental procedures were recorded by a research assistant who was also present in the room during sessions. Using the data sheet shown in Appendix K the research assistant observed whether the experimenter stated the correct incentive condition prior to the start of each trial and again at the end of the trial, along with each participant's incentive amount. A correct response for incentive condition type involved stating the incentive condition (i.e., fixed or individual). Correct responses for announcing the incentive amount involved telling each participant how much they earned on the previous trial. During fixed incentive conditions, a statement to the group as a whole (e.g., "you all earned $1.00 for this trial") was also considered a correct response. Procedural integrity data were collected during part or all of seven of the eight teams' sessions for a total of 82.3% of all trials conducted (79 out of 96 trials); procedural integrity was 100% for all trials recorded.

Intragroup communication and interobserver agreement. To measure the degree to which participants adhered to the communication manipulation as it was designed, the experimenter also collected data on intrateam communication. Data were recorded on whether participants engaged in any communication during or between trials. Communication was defined as any vocal verbal form of communication that included at least a single recognizable word. Thus, utterances (e.g., "oohhh," "ugh," "eghhh"), hand or body movements (e.g., nodding head, fist pumps), or other non-vocal verbal behaviors (e.g., banging the mouse on the table) were not scored. To assist in developing a more precise definition to be used on future research projects, we also attempted to classify communication as off-topic or relevant to the game; however, I did not make this distinction when evaluating data for the present study.

The research assistant recording procedural integrity data also recorded data for the purposes of calculating interobserver agreement (IOA) data using the same data sheet as shown in Appendix K. To calculate IOA, I used an interval-by-interval IOA procedure as described by Cooper, Heron, and Heward (2007). Specifically, I divided the number of intervals with an agreement by the total number of intervals for which secondary data were recorded and multiplied the result by 100 for each session. Agreements were defined as both data recorders indicating that a form of communication occurred or did not occur for the same interval. Mean IOA across all trials was 97% (range: 87.5-100%).

Results and Discussion

Demographic data. Demographic characteristics for participants in Experiment 2 are depicted in Table 7. Participants' ages ranged from 18-22 years (*M* = 19). Table 8 provides details of team compositions and participants' total incentives earned during the session.

Intrateam communication. Intrateam communication data are depicted in Table 9. Teams in the restricted condition rarely communicated, and there were only two occasions when communication occurred during a trial (both of those instances were brief). Two of the teams in the unrestricted condition engaged in a single occurrence of communication. Communication occurred during gameplay for only one team in the unrestricted condition, UR_3.

Group aggregates. Table 10 depicts aggregate trial totals for barrier reveals and score across communication and incentive type. Barrier reveal and score totals for each team are shown in Figure 8.

Communication. Trial totals for barrier reveals and score across the communication conditions are depicted in Figure 9. Teams in the restricted condition (*Mdn* = 14, 95% CI [9, 19]) revealed a similar number of barriers as those in the unrestricted condition (*Mdn* = 18, 95%

CI [7, 33]). Likewise, trial totals for score were similar for the restricted (*Mdn* = 68, 95% CI [63, 80]) and unrestricted (*Mdn* = 74, 95% CI [66, 81]) conditions. Mann-Whitney tests showed that there were no differences between the incentive types with respect to barrier reveals, $U = 1116$, $p = .794$, $d = 0.05$, or score, $U = 1103$, $p = .719$, $d = 0.07$.

Incentive type. Figure 10 shows trial totals for barrier reveals and score collapsed across communication conditions and separated by incentive type. Teams revealed more than twice as many barriers under a fixed incentive (*Mdn* = 23.5, 95% CI [12, 42]) than under an individual incentive (*Mdn* = 10.5, 95% CI [5, 17]). However, teams scored more points under an individual incentive (*Mdn* = 75.5, 95% CI [68, 87]) than under the fixed incentive (*Mdn* = 66.5, 95% CI [54, 74]). Mann-Whitney tests indicated statistically significant differences for barrier reveals, $U = 759$, $p = .004$, $d = 0.62$, and score, $U = 857.5$, $p = .031$, $d = 0.45$.

Price of cooperation. Figure 11 depicts mean barrier reveals across the range of prices of cooperation when separated by communication condition and incentive type separately. Figure 12 depicts barrier reveals when separated by each possible combination of communication and incentive condition. Demand curves fit to the data demonstrate systematic decreases in barrier reveals as a function of increasing price of cooperation for all analyses. Demand parameters and indices for each curve are shown in Table 11.

Communication. The top panel of Figure 11 depicts barrier reveals when separated by communication condition. Intensity (Q_0) and elasticity (α) were similar for both conditions, but the Extra sum-of-squares F test indicated that a single curve did not sufficiently fit both curves for the restricted and unrestricted data, $F(2,8) = 6.5$, $p = .021$.

Incentive type. The bottom panel of Figure 11 depicts barrier reveals when collapsed across communication condition and separated by incentive type. Overall, teams revealed fewer barriers at all prices and were more sensitive to increases in price under the individual condition. An Extra sum-of-squares *F* test confirmed that the data sets were better fit by separate curves, $F(2,8) = 245, p < .001$.

Communication x Incentive type. Demand curves for barrier reveals separated by communication and incentive condition combinations are depicted in Figure 12. Visual inspection of the curves suggests similar results for the combined conditions as when effects of each variable was observed separately. Specifically, the fixed-restricted and fixed-unrestricted curves were similar to one another, but with greater intensity and less elasticity than the individual-restricted and individual-unrestricted curves. An Extra sum-of-squares *F* test indicated that one curve does not adequately fit all four data sets, $F(6,16) = 53, p <.001$. Subsequent pairwise Extra sum-of-squares *F* tests indicated that no single curve adequately fit any two of the four conditions, with the exception of the comparison of the individual-restricted and individual-unrestricted conditions, $F(2,8) = 0.33, p = .728$ (all other $F\text{s}(2,8) > 47$, $p\text{s} < .001$). The shared curve combining the two individual restricted and individual unrestricted conditions is depicted in Figure 13.

Aggregate responding in the communication and incentive manipulations is summarized in Table 10. I observed no difference in responding between teams in the restricted and unrestricted communication conditions. With respect to the comparison of incentive type, teams revealed more barriers under the fixed incentive but scored more points under the individual incentive. That is, the teams were more cooperative, but less productive when pay was delivered noncontingently.

Within-session analyses of barrier reveals indicated that cooperative responses were sensitive to increases in price. Demand curve analyses supported findings from aggregate analyses of the differential effects of incentive type on responding. Further, the demand analyses indicated that teams working under the fixed condition had a higher intensity and lower elasticity of demand than under the individual condition. As with the aggregate-level comparison, within-session analyses revealed similar levels of responding across the communication conditions. However, demand curve analyses revealed significant differences in elasticity, with restricted teams more sensitive to increases in price than unrestricted teams. Finally, demand curve analyses of responses separated by communication and incentive condition combinations indicated that there was not a significant difference between restricted and unrestricted teams working under the individual incentive condition. Thus, the differential responding between restricted and unrestricted conditions can be explained by the difference observed under the fixed incentive condition.

One important limitation to note is that only two of the four teams in the unrestricted condition engaged in any form of communication. Although the experimental manipulation involved assessment of restricted versus unrestricted communication contexts, a lack communication within a team may have a similar functional effect on responding as the restricted communication arrangement.

General Discussion

The purpose of the present experiments was to evaluate a methodology that uses a behavioral economic framework to assess relations between incentives and social behaviors in a team-based work task. Additionally, to assess the utility of the COHESION program for use in evaluations of workplace performance, I examined effects of manipulations to antecedent and consequent variables that commonly affect employee behavior. The antecedent variable of interest, communication, produced varied results between the two experiments. In Experiment 1, the unrestricted team, who could talk amongst themselves, engaged in more cooperative and productive behaviors than the restricted team; whereas, I observed no difference between communication conditions in Experiment 2. I also observed varied results with the consequent variables, incentive type and probability, between experiments. There was little indication of effects of incentive manipulations in Experiment 1, but results indicated a significant difference between incentive conditions in Experiment 2.

I conducted a parametric analysis of constraints on cooperation by increasing barrier reveal duration within each trial. By plotting barrier reveal data across the six prices of cooperation and using demand analyses to fit curves to the data, I measured sensitivity to increases in price of cooperation across conditions. Across both experiments, I observed systematic decreases in cooperation as a function of increasing price, and general findings were consistent with those from trial-level analyses summarized previously. Demand curve analyses also indicated whether differential levels of responding observed at the trial level were consistent throughout the range of prices or were only apparent at higher prices of cooperation.

Findings from the present experiments are consistent with the varied literatures that informed my methodological approach. The unrestricted and restricted communication conditions were analogs to the social and nonsocial arrangements that Hake and Vukelich (1972) described as characteristic of cooperative behavior research. Although both conditions in the present experiments would likely be classified as social by Hake and Vukelich's definitions, they were arranged to be representative of different workplace contexts. For example, the unrestricted condition may resemble a modern open workplace, and a traditional office with individual cubicles may serve as a parallel to the restricted condition. The inconsistent findings across experiments may be due to different levels of intrateam communication. Whereas the unrestricted team in Experiment 1 communicated throughout the session, communication amongst unrestricted teams was minimal in Experiment 2. The present findings then are consistent with previous research suggesting that teams cooperate more when conditions are more social (e.g., Burnstein & Wolff, 1964), but that intrateam communication may be an important component responsible for increased cooperation (e.g., Hake & Vukelich, 1973).

I included different probabilities of incentive delivery as a consequent manipulation to assess the effects of reinforcement schedules on cooperation (i.e., barrier reveals) and productivity (i.e., score). Results are consistent with laboratory research suggesting that performance may be maintained on relatively low-probability random-ratio schedules of reinforcement (Catania, 2013). Although probabilities of incentive delivery for the 10% condition were obtained exactly as programmed (one out of nine trials for both teams), a potential confound is that both teams received the incentive on their first trial in the condition. Thus, the percentage of trials in the 10% condition for which they received an incentive started at 100% and may have maintained performance throughout the remainder of the experiment.

Although compensation is rarely based completely on performance, I evaluated the collective, fixed, and individual incentive types as analogs to naturalistic pay systems. I did not detect any difference between conditions in Experiment 1; however, removal of the probability manipulation and collective incentive condition allowed for more focused analyses. The finding in Experiment 2 that teams scored more points under individual incentive conditions than fixed conditions is consistent with previous research demonstrating that incentives delivered contingently maintain higher levels of performance than noncontingent incentives.

From an organizational perspective, increases in the price of cooperation may be considered analogous to greater work requirements associated with various job duties. For example, a cooperative task with a low price may involve picking up supplies from a storage room, whereas a high-priced task could entail training a coworker on a new protocol. Findings from the present study are consistent with Hake and Vukelich's (1973) findings that cooperation decreases as response effort increases. The importance of parametric analyses within the context of social behavior is highlighted when comparing across- versus within-trial data from the present experiments. For example, in Experiment 2, I did not detect a significant difference in cooperation across communication conditions in the trial-level analyses (Table 10, top panel of Figure 9). Likewise, visual inspection of within-trial responding (top panel of Figure 11) also indicated no difference in barrier reveals at low prices. However, at high prices of cooperation, differentiated levels of responding became apparent, demonstrating that responding at one price may not be representative of responding across a range of values.

Contributions to the Literature

There are several ways in which the present experiments provide contributions to the literature. First, the methods used provide a contemporary methodology for conducting social behavior research. Importantly, the current experiments build on existing literature as the methodology is consistent with the dimensions of previous cooperation research outlined by Hake and Vukelich (1972). The COHESION program addresses some limitations of previous human operant approaches as its versatility allows for parametric analyses of multiple behaviors and varying team sizes while maintaining an unstructured, free-operant context. Although some recent behavior analytic studies have evaluated human social behavior (e.g., Alavos, Iñesta, Ortiz, Villa, & Miranda, 2018; de Toledo et al., 2015; Jimenez & Pietras, 2018; Krockow, Colman, & Pulford, 2018; Vasconcelos & Todorov, 2015), there is limited discussion on the applicability of the research in recent literature. Thus, a related contribution of the present experiments is a demonstration of an area—OBM—that could benefit from social behavior research.

A second contribution of the present findings is the relation identified between incentives and social behavior. Taken together, trial-level and demand curve analyses indicated a clear functional relation between cooperation and incentive arrangement. This finding is noteworthy as it lends support to previous suggestions that incentives may affect social interactions within a team (e.g., Honeywell-Johnson & Dickinson, 1999) and may have important implications for OBM practitioners. For example, employers might consider how delivering incentives contingent on productivity alone may decrease cooperative responses and ultimately affect an organization's overall productivity. Thus, when arranging performance-based incentives, it may be important for desirable social behaviors to be included on performance evaluations. Further, workplaces with low levels of cooperation may experience increased burnout and turnover (Ganster et al., 2011; Hantula, 2015), leading to increased costs with personnel selection and training. With these considerations, future research might also evaluate the effects of incentive type on other social behaviors and interactions, such as competition and communication.

Third, the present findings add to a line of recent research examining applications of behavioral economics to OBM (e.g., Henley, DiGennaro Reed, Reed, et al., 2016; Hirst & DiGennaro Reed, 2016; Wine et al., 2012). In the present experiments, application of a behavioral economic framework allowed for detailed interpretation of the parametric analysis of responding across multiple prices of cooperation. Ultimately, this analysis led to the identification of differences between conditions that were not apparent in trial-level data. Further, using demand curves, researchers can make predictions of responding at untested prices, and derived metrics allow for comparisons across experiments.

Fourth, the present experiments extend the overall utility of demand curve analyses. In both experiments, I observed systematic decreases in cooperative behavior as a function of increases in the price of cooperation. These response patterns are consistent with a large body of research using demand curve analyses across multiple domains (Reed, Kaplan, & Becirevic, 2015). To my knowledge, few published studies have directly evaluated behavioral economic demand for nontangible or nonconsumable commodities in humans. Thus, the approach used in the present study contributes to behavioral economic literature by extending demand curve methodology to the analysis of a novel form of commodity.

One observation that may warrant additional research and further discussion is that there is no apparent or universal functional reinforcer of cooperative effort. That is, in the present experiments, I observed patterns of cooperative responding consistent with robust findings from previous research; however, unlike much of the extant literature, there is no clear delivery of a reinforcer in the present arrangement. In addition to sensitivity to price, I observed differentiated levels of responding across some but not all manipulations in the present experiments, which suggests that cooperation is not maintained automatically, but rather is sensitive to environmental variables. There are myriad potential controlling variables, and in-depth discussion is beyond the scope of this paper, but potential explanations may involve reinforcement through reciprocal exchange (e.g., Hake et al., 1975), histories of reinforcement for cooperation, or avoidance of potential aversive consequences for not cooperating. Thus, future research conducting functional analyses to identify variables maintaining cooperative effort may be beneficial as a parsimonious explanation may expand the generality of demand curve methodology.

The final major contribution involves the translational research approach to OBM. There are many challenges associated with conducting experimental evaluations in naturalistic work settings. For example, an OBM researcher interested in evaluating the effects of incentives may encounter ethical concerns associated with incentive arrangements that create unnecessary employee stress (e.g., Ganster et al., 2011) or opposition from labor unions, which have historically opposed compensation systems deemed to provide unfair benefits across employees (e.g., American Federation of Teachers, 2003). Likewise, when considering social behaviors, the varied nature of everyday work tasks makes it difficult to assess a single dimension of a constraint on social behaviors in natural settings. Thus, OBM researchers must identify practical methods to assess these complex human behaviors.

The human operant laboratory provides OBM researchers with a highly controlled setting where they can model organizational contexts and evaluate specific effects of behavioral principles on workplace performance (Hake, 1982; Mace & Critchfield, 2010). This use-inspired basic research (Stokes, 1997) provides vital insights on how basic behavioral principles directly affect workplace performance—an area with relatively limited research to date (DiGennaro Reed, Henley, Hirst, Doucette, & Jenkins, 2015; Poling et al., 2000). Related to the present experiments, researchers may use these methods to further compare incentive arrangements using demand curve analyses. Derived measures, such as *EV*, indicate under which incentive arrangements social behaviors may be more sensitive to increasing constraints and allows for comparison of sensitivity across conditions and across studies. Practitioners working in organizational settings may then use that information to arrange incentives in a manner that best promotes desired performance.

Limitations and Future Research

Interpretation of findings from the present experiments should be tempered as there are several limitations and areas that may call for future research. The experimental framework was designed with the assumption that COHESION serves as an analog to naturalistic work settings. Within this framework, I arranged the independent variables to model various factors that affect workplace performance. However, by design, the nature of the task is abstract and, thus, may not serve as an appropriate simulation of naturalistic work. Research extending this methodology may need to examine responding on tasks that better simulate workplace behaviors before findings can be appropriately translated into practice.

Another limitation is that, due to the translational nature of the experiment and novelty of the task, I arranged incentive types at the extreme ends of a continuum ranging from fixed to individual. However, arrangements where pay is completely tied to performance are rare and not representative of naturalistic settings. Future research in this area might involve evaluation of incentive systems commonly used in practice. Researchers might also examine responding under systems where incentives are delivered based on an individual's performance relative to the rest of the team or to only the top performer in each team. Under this type of system, cooperative responses may—in addition to the time required—also cost participants an opportunity at receiving an incentive, and the added constraint would likely decrease demand.

Another potential confound is the effect that variations in team composition may have on team-level responding. Demographic characteristics of participants in the present experiments were mostly homogenous across teams; however, I did not assess the degree to which participants knew one another. Previous interactions within teams, and related variables, likely affect cooperation, productivity, and intrateam communication. Future research might evaluate if there are any differential effects due to social familiarity and histories. Identification of such effects may be beneficial in identifying key areas for interventions aimed at increasing cooperation. However, it is also important to note that, in practice, employees have long histories of social interactions with one another which may be difficult to overcome. Thus, future research may also focus on identifying contexts and contingencies that promote desired responding in an efficient manner regardless of group composition.

Another area where findings from the aggregate analyses are limited is with respect to statistical power. Because trial-level data analysis involved examination of multiple trials from each team as individual data points, I believed it was more appropriate to use nonparametric tests to analyze aggregate data. However, devoid of a two-factor nonparametric test, I analyzed the data for each condition individually. This method decreased sample size and is unable to detect main or interaction effects. In addition, I did not conduct a power analysis prior to conducting the study. However, I conducted post-hoc power analyses based on observed effect size using G*Power 3.1.9.2 for macOS (Faul, Erdfelder, Lang, & Buchner, 2007), which identified that there was sufficient power at the recommended .80 level (Cohen, 1988) for three of the four aggregate-level comparisons that indicated significant differences between groups. Insufficient power was demonstrated in the Experiment 2 comparison of score between incentive conditions, $1-\beta = .57$. Future research may address these constraints by increasing the number of teams participating, identifying and using methodology that allows for use of more appropriate or advanced statistical tests, or using single case research methodology. (Note that demand curve analyses may be considered a form of single case research design, and as such future studies may focus on demand analyses as the primary method of analysis.)

A final limitation concerns the parameters involved in arranging the COHESION program. Although I used the same arrangement in both experiments, the program allows for modification of several variables, such as number of participants, barrier lifespan, and number of barriers per participant. Altering these parameters would likely change the gameplay experience and may lead to differential outcomes. Future research may focus on identifying how modifications to gameplay affect performance under various conditions. Importantly, a stronger understanding of how parameters affect gameplay may help in simulating various workplace contexts. For example, researchers could use the game to model cooperative behavior in settings where employees typically work independently (e.g., real estate) versus those where cooperation may be necessary for success (e.g., hospitals).

In sum, for the present experiments, I brought together research from multiple domains—performance management, social behavior, and behavioral economics—to evaluate contexts and contingencies that commonly affect workplace performance. Findings, although somewhat preliminary, are consistent with literature from the various areas of research that informed the conceptualization of these experiments. This synthesis of research across domains extends the generality of previous findings and further verifies the analytic approaches of each discipline (Bernard, 1927).

References

Allison, D. B., Silverstein, J. M., & Galante, V. (1993). Relative effectiveness and cost-effectiveness of cooperative, competitive, and independent monetary incentive systems. *Journal of Organizational Behavior Management, 13*(1), 85-112. https://doi.org/10.1300/J075v13n01_06

Alvero, A. M., Bucklin, B. R., & Austin, J. (2001). An objective review of the effectiveness and essential characteristics of performance feedback in organizational settings. *Journal of Organizational Behavior Management, 21*(1), 3-29. https://doi.org/10.1300/J075v21n01_02

American Federation of Teachers. (2003). Where we stand: Teacher quality. Retrieved from https://www.aft.org/sites/default/files/wws_teacherquality_2003.pdf

Amlung, M., & MacKillop, J. (2015). Further evidence of close correspondence for alcohol demand decision making for hypothetical and incentivized rewards. *Behavioural Processes, 113*, 187-191. https://doi.org/10.1016/j.beproc.2015.02.012

Austin, J. (2000). Performance analysis and performance diagnostics. In J. Austin & J. E. Carr (Eds.), *Handbook of applied behavior analysis* (pp. 321-349). Reno, NV: Context Press.

Austin, J., Kessler, M. L., Riccobono, J. E., & Bailey, J. S. (1996). Using feedback and reinforcement to improve the performance and safety of a roofing crew. *Journal of Organizational Behavior Management, 16*(2), 49-75. https://doi.org/10.1300/J075v16n02_04

Avalos, L. P., Iñesta, E. R., Ortiz, I. L., Villa, G. A. M., & Miranda, I. H. (2018). Effects of reciprocity induction on partial-altruistic and unequal-asymmetric labor exchange interactions. *The Psychological Record*. Advance online publication. https://doi.org/10.1007/s40732-018-0319-7

Axelrod, R. (1980). Effective choice in the prisoner's dilemma. *Journal of Conflict Resolution, 24*, 3-25. https://doi.org/10.1177/002200278002400101

Azrin, N. H., & Lindsley, O. R. (1956). The reinforcement of cooperation between children. *The Journal of Abnormal and Social Psychology, 52*, 100-102. https://doi.org/10.1037/h0042490

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*, 91-97. https://doi.org/10.1901/jaba.1968.1-91

Baker, J. C., Fairchild, K. M., & Seefeldt, D. A. (2015). Behavioral gerontology: Research and clinical considerations. In H. S. Roane, J. E. Ringdahl, & T. S. Falcomata (Eds.), *Clinical and organizational applications of applied behavior analysis* (pp. 425-450). Cambridge, Mass: Academic Press. https://doi.org/10.1016/B978-0-12-420249-8.00017-4

Balcazar, F. E., Hopkins, B. L., & Suarez, Y. (1985). A critical, objective review of performance feedback. *Journal of Organizational Behavior Management, 7*(3-4), 65-89. https://doi.org/10.1300/J075v07n03_05

Barnett, D. W., Daly III, E. J., Jones, K. M., & Lentz Jr, F. E. (2004). Response to intervention: Empirically based special service decisions from single-case designs of increasing and decreasing intensity. *The Journal of Special Education, 38*, 66-79. https://doi.org/10.1177/00224669040380020101

Becirevic, A., Reed, D. D., & Amlung, M. (2017). An initial investigation of the effects of tanning-related cues on demand and craving for indoor tanning. *The Psychological Record, 67*, 149-160. https://doi.org/10.1007/s40732-017-0246-z

Bernard, C. M. (1927). *Introduction à l'étude de la médecine expérimentale*. [An introduction to the study of experimental medicine] (H. C. Greene, Trans.). Retrieved from https://archive.org/details/b21270557 (Original work published 1865)

Bickel, W. K., Johnson, M. W., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The behavioral economics of substance use disorders: Reinforcement pathologies and their repair. *Annual Review of Clinical Psychology, 10,* 641-677. https://doi.org/10.1146/annurev-clinpsy-032813-153724

Bickel, W. K., & Madden, G. J. (1999). A comparison of measures of relative reinforcing efficacy and behavioral economics: Cigarettes and money in smokers. *Behavioural Pharmacology, 10*, 627-637. https://doi.org/10.1097/00008877-199911000-00009

Boyce, T. E., & Geller, E. S. (2001). Applied behavior analysis and occupational safety: The challenge of response maintenance. *Journal of Organizational Behavior Management*, *21*(1), 31-60. https://doi.org/10.1300/J075v21n01_03

Bucklin, B. R., & Dickinson, A. M. (2001). Individual monetary incentives: A review of different types of arrangements between performance and pay. *Journal of Organizational Behavior Management, 21*(3), 45-137. https://doi.org/10.1300/J075v21n03_03

Bureau of Labor Statistics (2017). American time use survey. Retrieved from https://www.bls.gov/tus/charts.htm

Burgio, L. D., & Burgio, K. L. (1986). Behavioral gerontology: Application of behavioral methods to the problems of older adults. *Journal of Applied Behavior Analysis, 19*, 321-328. https://doi.org/10.1901/jaba.1986.19-321

Burnstein, D. D., & Wolff, P. C. (1964). Shaping of three-man teams on a multiple DRL-DRH schedule using collective reinforcement. *Journal of the Experimental Analysis of Behavior, 7*, 191-197. https://doi.org/10.1901/jeab.1964.7-191

Camden, M. C., & Ludwig, T. D. (2013). Absenteeism in health care: Using interlocking behavioral contingency feedback to increase attendance with certified nursing assistants. *Journal of Organizational Behavior Management, 33*, 165-184. https://doi.org/10.1080/01608061.2013.814521

Casella, S. E., Wilder, D. A., Neidert, P., Rey, C., Compton, M., & Chong, I. (2010). The effects of response effort on safe performance by therapists at an autism treatment facility. *Journal of Applied Behavior Analysis, 43*, 729-734. https://doi.org/10.1901/jaba.2010.43-729

Catania, C. A. (2013). Learning (5th ed.). Cornwall-on-Hudson, NY: Sloan.

Choi, J. K., & Ahn, T. K. (2013). Strategic reward and altruistic punishment support cooperation in a public goods game experiment. *Journal of Economic Psychology, 35*, 17-30. https://doi.org/10.1016/j.joep.2013.01.001

Cohen, B. H. (2008). *Explaining psychological statistics* (3rd ed.). Hoboken, NJ: Wiley.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007) *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson.

Daniels, A. C. (2016). *Bringing out the best in people: How to apply the astonishing power of positive reinforcement* (3rd ed.). New York, NY: McGraw-Hill.

Daniels, A. C., & Bailey, J. S. (2014). *Performance management: Changing behavior that drives organizational performance* (5th ed.). Atlanta, GA: Performance Management Publications.

Dawes, R. M. (1980). Social dilemmas. *Annual Review of Psychology, 31*, 169-193. https://doi.org/10.1146/annurev.ps.31.020180.001125

de Toledo, T. F. N., Benvenuti, M. F. L., Sampaio, A. A. S., Marques, N. S., dos Anjos Cabral, P. A., de Souza Araújo, L. A., . . . Moreira, L. R. (2015). Free culturant: A software for the experimental study of behavioral and cultural selection. *Psychology & Neuroscience, 8*, 366-384. https://doi.org/10.1037/pne0000016

Dickinson, A. M., & Gillette, K. L. (1994). A comparison of the effects of two individual monetary incentive systems on productivity: Piece rate pay versus base pay plus incentives. *Journal of Organizational Behavior Management, 14*(1), 3-82. https://doi.org/10.1300/J075v14n01_02

Diener, L. H., McGee, H. M., & Miguel, C. F. (2009). An integrated approach for conducting a behavioral systems analysis. *Journal of Organizational Behavior Management, 29*, 108-135. https://doi.org/10.1080/01608060902874534

Dierks, W., & McNally, K. (1987). Incentives you can bank on. *The Personnel Administrator, 32*(3), 60-65.

DiGennaro Reed, F. D., Henley, A. J., Hirst, J. M., Doucette, J. L., & Jenkins, S. R. (2015). Basic research considerations for the performance management of staff. In F.D. DiGennaro Reed & D. D. Reed (Eds.), *Autism service delivery: Bridging the gap between* *science and practice* (pp. 437-463). New York: Springer. https://doi.org/10.1007/978-1-4939-2656-5_16

Dixon, M. R., Marley, J., & Jacobs, E. A. (2003). Delay discounting by pathological gamblers. *Journal of Applied Behavior Analysis*, *36*, 449-458. https://doi.org/10.1901/jaba.2003.36-449

Duncan, P. K., & Bruwelheide, L. R. (1985). Feedback: Use and possible behavioral functions. *Journal of Organizational Behavior Management, 7*(3-4), 91-114. https://doi.org/10.1300/J075v07n03_06

Emurian, H. H., Canfield, G. C., Roma, P. G., Brinson, Z. S., Gasior, E. D., Hienz, R. D., ... & Brady, J. V. (2011). A multiplayer team performance task: Design and evaluation. In M. M. Cruz-Cunha, V. Varvalho, & P. Tavares (Eds.), *Business, technological, and social dimensions of computer games: Multidisciplinary developments* (pp. 201-219). Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-60960-567-4.ch013

Farr, J. L. (1976). Incentive schedules, productivity, and satisfaction in work groups: A laboratory study. *Organizational Behavior and Human Performance, 17*, 159-170. https://doi.org/10.1016/0030-5073(76)90059-3

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191. https://doi.org/10.3758/BF03193146

Fehr, E., & Gächter, S. (2002). Altruistic punishment in humans. *Nature, 415*, 137-140. https://doi.org/10.1038/415137a

Fellner, D. J., & Sulzer-Azaroff, B. (1984). A behavioral analysis of goal setting. *Journal of Organizational Behavior Management, 6*(1), 33-51. https://doi.org/10.1300/J075v06n01_03

Fischbacher, U., Gächter, S., & Fehr, E. (2001). Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters, 71*, 397-404. https://doi.org/10.1016/S0165-1765(01)00394-9

Frisch, C. J., & Dickinson, A. M. (1990). Work productivity as a function of the percentage of monetary incentives to base pay. *Journal of Organizational Behavior Management, 11*(1), 13-33. https://doi.org/10.1300/J075v11n01_03

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, *141*, 2-18. https://doi.org/10.1037/a0024338

Ganster, D. C., Kiersch, C. E., Marsh, R. E., & Bowen, A. (2011). Performance-based rewards and work stress. *Journal of Organizational Behavior Management, 31*, 221-235. https://doi.org/10.1080/01608061.2011.619388

Gilroy, S. P., Kaplan, B. A., & Leader, G. (2018). A systematic review of applied behavioral economics in assessments and treatments for individuals with developmental disabilities. *Review Journal of Autism and Developmental Disorders, 5*, 247-259. https://doi.org/10.1007/s40489-018-0136-6

Gilroy, S. P., Kaplan, B. A., Reed, D. D., Koffarnus, M. N., & Hantula, D. A. (2018). The Demand Curve Analyzer: Behavioral economic software for applied research. *Journal of the Experimental Analysis of Behavior*. Advance online publication. https://doi.org/10.1002/jeab.479

Glenn, S. S. (1988). Contingencies and metacontingencies: Toward a synthesis of behavior analysis and cultural materialism. *The Behavior Analyst, 11*, 161-179. https://doi.org/10.1007/BF03392470

Glenn, S. S. (2004). Individual Behavior, Culture, and Social Change. *The Behavior Analyst, 27*, 133-151. https://doi.org/10.1007/BF03393175

Gross, S. E. (1995). *Compensation for teams: How to design and implement team-based reward programs*. New York, NY: AMACOM.

Hackenberg, T. D., & Joker, V. R. (1994). Instructional versus schedule control of humans' choices in situations of diminishing returns. *Journal of the Experimental Analysis of Behavior, 62*, 367-383. https://doi.org/10.1901/jeab.1994.62-367

Hake, D. F. (1982). The basic-applied continuum and the possible evolution of human operant social and verbal research. *The Behavior Analyst, 5*, 21-28. https://doi.org/10.1007/BF03393137

Hake, D. F., Olvera, D., & Bell, J. C. (1975). Switching from competition to sharing or cooperation at large response requirements: Competition requires more responding. *Journal of the Experimental Analysis of Behavior, 24*, 343-354. https://doi.org/10.1901/jeab.1975.24-343

Hake, D. F., & Vukelich, R. (1972). A classification and review of cooperation procedures. *Journal of the Experimental Analysis of Behavior, 18*, 333-343. https://doi.org/10.1901/jeab.1972.18-333

Hake, D. F., & Vukelich, R. (1973). Analysis of the control exerted by a complex cooperation procedure. *Journal of the Experimental Analysis of Behavior, 19*, 3-16. https://doi.org/10.1901/jeab.1973.19-3

Hantula, D. A. (2015). Job satisfaction: The management tool and leadership responsibility. *Journal of Organizational Behavior Management*, *35*, 81-94. https://doi.org/10.1080/01608061.2015.1031430

Harris, A. C., & Madden, G. J. (2002). Delay discounting and performance on the prisoner's dilemma game. *The Psychological Record, 52*, 429-440. https://doi.org/10.1007/BF03395196

Henley, A. J., DiGennaro Reed, F. D., Kaplan, B. A., & Reed, D. D. (2016). Quantifying efficacy of workplace reinforcers: An application of behavioral economic demand to evaluate hypothetical work performance. *Translational Issues in Psychological Science, 2*, 174-183. https://doi.org/10.1037/tps0000068

Henley, A. J., DiGennaro Reed, F. D., Reed, D. D., & Kaplan, B. A. (2016). A crowdsourced nickel-and-dime approach to analog OBM research: A behavioral economic framework for understanding workforce attrition. *Journal of the Experimental Analysis of Behavior, 106*, 134-144. https://doi.org/10.1002/jeab.220

Higgins, S. T., Delaney, D. D., Budney, A. J., Bickel, W. K., Hughes, J. R., Foerg, F., & Fenwick, J. W. (1991). A behavioral approach to achieving initial cocaine abstinence. *American Journal of Psychiatry, 148*, 1218-1224. https://doi.org/10.1176/ajp.148.9.1218

Hirst, J. M., & Reed, F. D. D. (2015). An examination of the effects of feedback accuracy on academic task acquisition in analogue settings. *The Psychological Record*, *65*, 49-65. https://doi.org/10.1007/s40732-016-0201-4

Honeywell, J. A., Dickinson, A. M., & Poling, A. (1997). Individual performance as a function of individual and group pay contingencies. *The Psychological Record, 47*, 261-274. https://doi.org/10.1007/BF03395224

Honeywell-Johnson, J. A., & Dickinson, A. M. (1999). Small group incentives: A review of the literature. *Journal of Organizational Behavior Management, 19*(2), 89-120. https://doi.org/10.1300/J075v19n02_06

Hursh, S. R. (1980). Economic concepts for the analysis of behavior. *Journal of the Experimental Analysis of Behavior, 34*, 219-238. https://doi.org/10.1901/jeab.1980.34-219

Hursh, S. R. (1984). Behavioral economics. *Journal of the Experimental Analysis of Behavior, 42*, 435-452. https://doi.org/10.1901/jeab.1984.42-435

Hursh, S. R. (2014). Behavioral economics and the analysis of consumption and choice. In F. K. McSweeney & E. S. Murphy (Eds.). *The Wiley Blackwell handbook of operant and classical conditioning* (pp. 275-305). Hoboken, NY: Wiley. https://doi.org/10.1002/9781118468135.ch12

Hursh, S. R., Raslear, T. G., Bauman, R., & Black, H. (1989). The quantitative analysis of economic behavior with laboratory animals. In K. G. Grunert & F. Ölander (Eds.), *Understanding economic behaviour* (pp. 393-407). New York, NY: Kluwer Academic Publishers, Theory and Decision Library. https://doi.org/10.1007/978-94-009-2470-3_22

Hursh, S. R., & Roma, P. G. (2013). Behavioral economics and empirical public policy. *Journal of the Experimental Analysis of Behavior, 99*, 98-124. https://doi.org/10.1002/jeab.7

Hursh, S. R., & Silberberg, A. (2008). Economic demand and essential value. *Psychological Review, 115*, 186-198. https://doi.org/10.1037/0033-295X.115.1.186

Jacobs, E. A., & Bickel, W. K. (1999). Modeling drug consumption in the clinic using simulation procedures: Demand for heroin and cigarettes in opioid-dependent outpatients.

Experimental and Clinical Psychopharmacology, 7, 412-426. https://doi.org/10.1037/1064-1297.7.4.412

Jarmolowicz, D. P., Reed, D. D., DiGennaro Reed, F. D., & Bickel, W. K. (2016). The behavioral and neuroeconomics of reinforcer pathologies: Implications for managerial and health decision making. *Managerial and Decision Economics, 37*, 274-293. https://doi.org/10.1002/mde.2716

Jenkins, G. D., Jr., Mitra, A., Gupta, N., & Shaw, J. D. (1998). Are financial incentives related to performance? A meta-analytic review of empirical research. *Journal of Applied Psychology, 83*, 777-787. https://doi.org/10.1037/0021-9010.83.5.777

Jimenez, S., & Pietras, C. (2018). An investigation of the probability of reciprocation in a risk reduction model of sharing. *Behavioural Processes*. Advance online publication. https://doi.org/10.1016/j.beproc.2018.04.012

Johnson, M. W., & Bruner, N. R. (2012). The Sexual Discounting Task: HIV risk behavior and the discounting of delayed sexual rewards in cocaine dependence. *Drug and Alcohol Dependence, 123*, 15-21. https://doi.org/10.1016/j.drugalcdep.2011.09.032

Johnston, J. M., & Pennypacker, H. S. (2009). *Strategies and tactics of behavioral research* (3rd ed.). New York, NY: Routlege.

Jones, B. A., & Rachlin, H. (2009). Delay, probability, and social discounting in a public goods game. *Journal of the Experimental Analysis of Behavior, 91*, 61-73. https://doi.org/10.1901/jeab.2009.91-61

Jones, R. R., Weinrott, M. R., & Vaught, R. S. (1978). Effects of serial dependency on the agreement between visual and statistical inference. *Journal of Applied Behavior Analysis*, *11*, 277-283. https://doi.org/10.1901/jaba.1978.11-277

Kaplan, B. A., & Reed, D. D. (2014). Essential value, $P_{\max}$, and $O_{\max}$ automated calculator [spreadsheet application]. Retrieved from http://hdl.handle.net/1808/14934.

Koffarnus, M. N., Franck, C. T., Stein, J. S., & Bickel, W. K. (2015). A modified exponential behavioral economic demand model to better describe consumption data. *Experimental and Clinical Psychopharmacology, 23*, 504-512. https://doi.org/10.1037/pha0000045

Kortick, S. A., & O'Brien, R. M. (1996). The world series of quality control: A case study in the package delivery industry. *Journal of Organizational Behavior Management, 16*(2), 77-93. https://doi.org/10.1300/J075v16n02_05

Krockow, E. M., Colman, A. M., & Pulford, B. D. (2018). Dynamic probability of reinforcement for cooperation: Random game termination in the centipede game. *Journal of the Experimental Analysis of Behavior*, *109*, 349-364. https://doi.org/10.1002/jeab.320

Lappalainen, R., & Epstein, L. H. (1990). A behavioral economics analysis of food choice in humans. *Appetite, 14*, 81-93. https://doi.org/10.1016/0195-6663(90)90002-P

Lenhard, W., & Lenhard, A. (2016). *Calculation of effect sizes*. [Online calculator]. Dettelbach, Germany. https://doi.org/10.13140/RG.2.1.3478.4245

Lindsley, O. R. (1966). Experimental analysis of cooperation and competition. In T. Verhave (Ed.) *The experimental analysis of behavior* (pp. 470-501). New York, NY: Appleton-Century-Crofts, Inc.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3-9. https://doi.org/10.1037/0022-006X.55.1.3

Mace, F. C., & Critchfield, T. S. (2010). Translational research in behavior analysis: Historical traditions and imperative for the future. *Journal of the Experimental Analysis of Behavior, 93*, 293-312. https://doi.org/10.1901/jeab.2010.93-293

Marwell, G., & Schmitt, D. R. (1972). Cooperation in a three-person Prisoner's Dilemma. *Journal of Personality and Social Psychology, 21*, 376-383. https://doi.org/10.1037/h0032319

Marwell, G., Schmitt, D. R., & Shotola, R. (1971). Cooperation and interpersonal risk. *Journal of Personality and Social Psychology, 18*, 9-32. https://doi.org/10.1037/h0030707

Matthews, B. A. (1977). Magnitudes of score differences produced within sessions in a cooperative exchange procedure. *Journal of the Experimental Analysis of Behavior, 27*, 331-340. https://doi.org/10.1901/jeab.1977.27-331

Milkovich, G. T., & Stevens, J. (1999). Back to the future: A century of compensation. *CAHRS Working Paper Series, 107*, 1-21. Retrieved from https://digitalcommons.ilr.cornell.edu/cahrswp/107/

Milkovich, G. T., & Stevens, J. (2000). From pay to rewards: 100 years of change. *ACA Journal, 9*(1), 6-18.

Miller, J. R., Hirst, J. M., Kaplan, B. A., DiGennaro Reed, F. D., & Reed, D. D. (2014). Effects of mands on instructional control: A laboratory simulation. *Analysis of Verbal Behavior, 30*, 100-112. https://doi.org/10.1007/s40616-014-0015-x

Miltenberger, R. G. (2015). *Behavior modification: Principles and procedures* (6th ed.). Boston, Mass: Cengage Learning.

Mithaug, D. E. (1969). The development of cooperation in alternative task situations. *Journal of Experimental Child Psychology, 8*, 443-460. https://doi.org/10.1016/0022-0965(69)90117-9

Nastally, B. L., & Dixon, M. R. (2012). The effect of a brief acceptance and commitment therapy intervention on the near-miss effect in problem gamblers. *The Psychological Record, 62*, 677-690. https://doi.org/10.1007/BF03395828

Neef, N. A., Shade, D., & Miller, M. S. (1994). Assessing influential dimensions of reinforcers on choice in students with serious emotional disturbance. *Journal of Applied Behavior Analysis, 27*, 575-583. https://doi.org/10.1901/jaba.1994.27-575

Neidert, P. L., Dozier, C. L., Iwata, B. A., & Hafen, M. (2010). Behavior analysis in intellectual and developmental disabilities. *Psychological Services, 7*, 103-113. https://doi.org/10.1037/a0018791

Oah, S., & Lee, J. H. (2011). Effects of hourly, low-incentive, and high-incentive pay on simulated work productivity: Initial findings with a new laboratory method. *Journal of Organizational Behavior Management, 31*, 21-42. https://doi.org/10.1080/01608061.2011.541820

Parsons, M. B., Rollyson, J. H., & Reid, D. H. (2012). Evidence-based staff training: A guide for practitioners. *Behavior Analysis in Practice, 5*, 2-11. https://doi.org/10.1007/BF03391819

Peach, E. B., & Wren, D. A. (1991). Pay for performance from antiquity to the 1950s. *Journal of Organizational Behavior Management, 12*(1), 5-26. https://doi.org/10.1300/J075v12n01_02

Persky, J. (1995). The ethology of homo economicus. *Journal of Economic Perspectives, 9*, 221-231. https://doi.org/10.1257/jep.9.2.221

Peters, H. N., & Murphree, O. D. (1954). A cooperative multiple-choice apparatus. *Science, 119*, 189-191. https://doi.org/10.1126/science.119.3084.189-a

Peterson, N. (1982). Feedback is not a new principle of behavior. *The Behavior Analyst, 5*, 101-102. https://doi.org/10.1007/BF03393144

Poling, A., Dickinson, A. M., Austin, J., & Normand, M. P. (2000). Basic behavioral research and organizational behavior management. In J. Austin & J. E. Carr (Eds.), *Handbook of applied behavior analysis* (pp. 295-320). Reno, CA: Context Press.

Reed, D. D., Kaplan, B. A., & Becirevic, A. (2015). Basic research on the behavioral economics of reinforcer value. In F. D. DiGennaro Reed & D. D. Reed (Eds.), *Autism service delivery: Bridging the gap between science and practice* (pp. 437-463). New York: Springer. https://doi.org/10.1007/978-1-4939-2656-5_10

Revenue Act of 1978, Pub. L. No. 95-600 §135a (1980).

Riedel, J. A., Nebeker, D. M., & Cooper, B. L. (1988). The influence of monetary incentives on goal choice, goal commitment, and task performance. *Organizational Behavior and Human Decision Processes, 42*, 155-180. https://doi.org/10.1016/0749-5978(88)90010-6

Roma, P. G., Hursh, S. R., & Hudja, S. (2015). Hypothetical purchase task questionnaires for behavioral economic assessments of value and motivation. *Managerial and Decision Economics, 37*, 306-323. https://doi.org/10.1002/mde.2718

Roma, P. G., Reed, D. D., DiGennaro Reed, F. D., & Hursh, S. R. (2017). Progress of and prospects for hypothetical purchase task questionnaires in consumer behavior analysis and public policy. *The Behavior Analyst, 40*, 329-342. https://doi.org/10.1007/s40614-017-0100-2

Sally, D. (1995). Conversation and cooperation in social dilemmas: A meta-analysis of experiments from 1958 to 1992. *Rationality and Society, 7*, 58-92. https://doi.org/10.1177/1043463195007001004

Samuelson, P. A., & Nordhaus, W. D. (2009). *Economics* (19th ed.). New York, NY: McGraw-Hill.

Schmitt, D. R. (1998). Social behavior. In K. A. Lattal & M. Perone (Eds.), *Handbook of research methods in human operant behavior* (pp. 471-505). Boston, Mass: Springer. https://doi.org/10.1007/978-1-4899-1947-2_15

Schmitt, D. R., & Marwell, G. (1968). Stimulus control in the experimental study of cooperation *Journal of the Experimental Analysis of Behavior, 11*, 571-574. https://doi.org/10.1901/jeab.1968.11-571

Shimoff, E., & Matthews, B. A. (1975). Unequal reinforcer magnitudes and relative preference for cooperation in the dyad. *Journal of the Experimental Analysis of Behavior, 24*, 1-16. https://doi.org/10.1901/jeab.1975.24-1

Sidman. (1960). *Tactics of scientific research: Evaluating experimental data in psychology.* Boston, Mass: Authors Cooperative.

Sidowski, J. B. (1957). Reward and punishment in a minimal social situation. *Journal of Experimental Psychology, 54*, 318-326. https://doi.org/10.1037/h0047119

Siegal, S. (1956). *Nonparametric statistics for the behavioral sciences*. New York, NY: McGraw Hill.

Sigurdsson, S. O., Ring, B. M., & Warman, A. (2018). Performer-level interventions: Consequences. In B. Wine & J. Pritchard (Eds.), *Organizational behavior management: The essentials* (pp. 217-244). Orlando, FL: Hedgehog Publishers.

Sigurdsson, S. O., Taylor, M. A., & Wirth, O. (2013). Discounting the value of safety: Effects of perceived risk and effort. *Journal of Safety Research, 46*, 127-134. https://doi.org/10.1016/j.jsr.2013.04.006

Skinner, B. F. (1953). *Science and human behavior*. New York, NY: Free Press.

Skinner, B. F. (1962). Two "synthetic social relations." *Journal of the Experimental Analysis of Behavior, 5*, 531-533. https://doi.org/10.1901/jeab.1962.5-531

Slowiak, J. M., Madden, G. J., & Mathews, R. (2006). The effects of a combined task clarification, goal setting, feedback, and performance contingent consequence intervention package on telephone customer service in a medical clinic environment. *Journal of Organizational Behavior Management, 25*(4), 15-35. https://doi.org/10.1300/J075v25n04_02

Stokes, D. E. (1997). *Pasteur's quadrant: Basic science and technological innovation*. Washington, D. C: Brookings Institution Press.

Stolovitch, H. D., Clark, R. E., & Condly, S. J. (2002). *Incentives, motivation and workplace performance: Research & best practices.* Retrieved from http://theirf.org/research/incentives-motivation-and-workplace-performance-research-and-best-practices/147/

Stoneman, K. G., & Dickinson, A. M. (1989). Individual performance as a function of group contingencies and group size. *Journal of Organizational Behavior Management, 10*(1), 131-150. https://doi.org/10.1300/J075v10n01_08

Tan, L., & Hackenberg, T. D. (2016). Functional analysis of mutual behavior in laboratory rats (Rattus norvegicus). *Journal of Comparative Psychology, 130*, 13-23. https://doi.org/10.1037/com0000015

Thyer, B. A. (1999). Clinical behavior analysis and clinical social work: A mutually reinforcing relationship. *The Behavior Analyst, 22*, 17-29. https://doi.org/10.1007/BF03391974

Tittelbach, D., DeAngelis, M., Sturmey, P., & Alvero, A. M. (2007). The effects of task clarification, feedback, and goal setting on student advisors' office behaviors and customer service. *Journal of Organizational Behavior Management, 27*(3), 27-37. https://doi.org/10.1300/J075v27n03_03

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. S*cience, 211*, 453-458. https://doi.org/10.1126/science.7455683

VanStelle, S. E., Vicars, S. M., Harr, V., Miguel, C. F., Koerber, J. L., Kazbour, R., & Austin, J. (2012). The publication history of *Journal of Organizational Behavior Management:* An objective review and analysis: 1998-2009. *Journal of Organizational Behavior Management, 32*, 93-123. https://doi.org/10.1080/01608061.2012.675864

Vasconcelos, I. G., & Todorov, J. C. (2015). Experimental analysis of the behavior of persons in groups: Selection of an aggregate product in a metacontingency. *Behavior and Social Issues*, *24*, 111-125. https://doi.org/10.5210/bsi.v.24i0.5424

Wagner, K. I., & Bailey, J. S. (1998). The effects of a monetary incentive system on work performance of mental health counselors. *Performance Improvement Quarterly, 11*, 64-78. https://doi.org/10.1111/j.1937-8327.1998.tb00100.x

West, S. A., Griffin, A. S., & Gardner, A. (2007). Social semantics: altruism, cooperation, mutualism, strong reciprocity and group selection. *Journal of Evolutionary Biology, 20*, 415-432. https://doi.org/10.1111/j.1420-9101.2006.01258.x

Wilder, D. A., Austin, J., & Casella, S. (2009). Applying behavior analysis in organizations: Organizational behavior management. *Psychological Services, 6*, 202-211. https://doi.org/10.1037/a0015393

Wine, B., Gilroy, S., & Hantula, D. A. (2012). Temporal (in)stability of employee preferences for rewards. *Journal of Organizational Behavior Management, 32*, 58-64. https://doi.org/10.1080/01608061.2012.646854

Yi, R., Buchhalter, A. R., Gatchalian, K. M., & Bickel, W. K. (2007). The relationship between temporal discounting and the prisoner's dilemma game in intranasal abusers of prescription opioids. *Drug and Alcohol Dependence, 87*, 94-97. https://doi.org/10.1016/j.drugalcdep.2006.07.007

Yi, R., Johnson, M. W., & Bickel, W. K. (2005). Relationship between cooperation in an iterated prisoner's dilemma game and the discounting of hypothetical outcomes. *Learning & Behavior, 33*, 324-336. https://doi.org/10.3758/BF03192861

Yu, J., Liu, L., Collins, R. L., Vincent, P. C., & Epstein, L. H. (2014). Analytical problems and suggestions in the analysis of behavioral economic demand curves. *Multivariate Behavioral Research, 49*, 178–192. https://doi.org/10.1080/00273171.2013.862491

Table 1

Experiment 1 Participant Demographic Characteristics

Demographic	*n*
Age (years)	
18	1
19	4
20	1
Gender	
Female	6
Male	0
Ethnicity	
White/Caucasian	3
Black/African American	0
Hispanic/Latino	2
Asian	1
Native American	0
Biracial/Multiracial	0
Other	0
Disability	
Yes	0
No	6
English as first language	
Yes	5
No	1

Table 2

Experiment 1 Team Composition

Team	Participant	Age	Gender	Earnings
Restricted	1	18	Female	\$17.56
	2	20	Female	\$21.06
	3	19	Female	\$22.96
Unrestricted	1	19	Female	\$25.88
	2	19	Female	\$29.18
	3	19	Female	\$27.18

Note: Earnings do not include the \$10.00 for participation in the experiment.

Table 3

Experiment 1 Group Aggregates by Communication Condition

Condition	*n*	*Mdn*	95% CI[a]	Normal Dist.[b]	*U*	*p*	*d*
				Barrier Reveals			
Communication					10	< .001	2.68
Restricted	18	10.5	[5, 38]	Yes			
Unrestricted	18	77.5	[74, 87]	Yes			
				Score			
Communication					32	< .001	1.88
Restricted	18	84.0	[71, 93]	Yes			
Unrestricted	18	113.5	[104, 124]	Yes			

[a]95% confidence interval of the median. [b]D'Agostino-Pearson omnibus normality test ($\alpha = .05$).

Table 4

Experiment 1 Group Aggregates by Communication and Probability Condition

Condition	*n*	*Mdn*	95% CI[a]	Normal Dist.[b]	*U*	*p*	*d*
				Barrier Reveals			
Restricted					19.5	.066	0.97
10%	9	5	[1, 41]	Yes			
100%	9	28	[8, 64]	Yes			
Unrestricted					36	.715	0.19
10%	9	76	[58, 88]	Yes			
100%	9	79	[73, 90]	Yes			
				Score			
Restricted					19.5	.065	0.97
10%	9	88	[79, 107]	Yes			
100%	9	72	[61, 91]	Yes			
Unrestricted					37.5	.812	0.13
10%	9	114	[104, 124]	Yes			
100%	9	113	[89, 138]	Yes			

[a]95% confidence interval of the median. [b]D’Agostino-Pearson omnibus normality test ($\alpha = .05$).

Table 5

Experiment 1 Group Aggregates by Communication and Incentive Type Condition

Condition	*n*	*Mdn*	95% CI[a]	Normal Dist.[b]	*H*(2)	*p*	η^2
				Barrier Reveals			
Restricted					1.5	.489	0.033
Collective	6	22	[5, 53]	Yes			
Fixed	6	6	[0, 64]	Yes			
Individual	6	8	[5, 75]	Yes			
Unrestricted					1.96	.394	0.107
Collective	6	77	[73, 84]	Yes			
Fixed	6	77	[58, 92]	Yes			
Individual	6	75	[54, 90]	Yes			
				Score			
Restricted					1.67	.453	0.103
Collective	6	97	[61, 107]	Yes			
Fixed	6	79	[67, 90]	No			
Individual	6	84	[56, 113]	No			
Unrestricted					1.25	.558	0.096
Collective	6	99	[97, 154]	Yes			
Fixed	6	109	[79, 125]	Yes			
Individual	6	113	[89, 126]	Yes			

[a]95% confidence interval of the median. [b]Shapiro-Wilk normality test ($\alpha = .05$).

Table 6

Experiment 1 Demand Parameters and Metrics

Curve	k	R^2	Q_0	α	EV	P_{max}	O_{max}
Restricted							
10%							
Collective	2.5	.83	11.0	.0160	0.158	1.23	4.41
Fixed	2.5	.04	0.5	.0360	0.070	12.82	1.96
Individual	2.5	.61	4.4	.0120	0.211	4.11	5.88
100%							
Collective	2.5	.92	8.4	.0110	0.230	2.35	6.42
Fixed	2.5	.91	12.0	.0086	0.294	2.10	8.21
Individual	2.5	.84	6.8	.0053	0.477	6.02	13.32
Unrestricted							
10%							
Collective	2.5	.94	33.0	.0046	0.550	1.43	15.35
Fixed	2.5	.76	33.0	.0045	0.562	1.46	15.69
Individual	2.5	.93	32.0	.0051	0.496	1.33	13.84
Shared 10%[a]	2.5	.85	33.0	.0047	0.538	1.40	15.02
100%							
Collective	2.5	.90	34.0	.0042	0.602	1.52	16.81
Fixed	2.5	.76	34.0	.0041	0.617	1.56	17.22
Individual	2.5	.86	49.0	.0058	0.436	0.76	12.17
Shared 100%[b]	2.5	.77	40.0	.0049	0.516	1.11	14.41
Shared Unrestricted[c]	2.5	.80	36.0	.0048	0.527	1.26	14.71

[a]Single best-fit curve fitting three conditions in Restricted-10%. [b]Single best-fit curve fitting three conditions in Unrestricted 100%. [c]Single best-fit curve fitting all six conditions for unrestricted team.

Table 7

Experiment 2 Participant Demographic Characteristics

Demographic	*n*
Age (years)	
18	12
19	6
20	2
21	3
22	1
Gender	
Female	20
Male	4
Ethnicity	
White/Caucasian	20
Black/African American	0
Hispanic/Latino	1
Asian	1
Native American	0
Biracial/Multiracial	2
Other	0
Disability	
Yes	4
No	20
Disability Type[a]	
Learning Disability	1
ADHD	3
Physical Disability	0
Other	1
English as first language	
Yes	24
No	0

[a]More than one disability may be listed.

Table 8

Experiment 2 Team Composition

Team	Participant	Age	Gender	Earnings
R_1	1	20	Male	$31.90
	2	19	Male	$25.60
	3	19	Female	$20.80
R_2	1	19	Female	$17.30
	2	19	Female	$25.30
	3	18	Female	$19.60
R_3	1	18	Female	$17.50
	2	20	Female	$15.10
	3	18	Female	$17.50
R_4	1	21	Female	$22.20
	2	18	Female	$22.40
	3	18	Female	$21.80
UR_1	1	18	Female	$24.30
	2	22	Male	$24.50
	3	18	Female	$20.80
UR_2	1	18	Female	$24.80
	2	19	Female	$17.20
	3	21	Male	$21.20
UR_3	1	19	Female	$27.70
	2	18	Female	$25.90
	3	18	Female	$19.70
UR_4	1	18	Female	$19.40
	2	18	Female	$19.80
	3	21	Female	$16.00

Note: Earnings do not include the $10.00 for participation in the experiment.

Table 9

Experiment 2 Occurrence of Intrateam Communication

Team	Pre-trial	Within-trial	Total
R_1	0	1	1
R_2	0	0	0
R_3	2	0	2
R_4	1	1	2
Restricted Total	3	2	5
UR_1	0	0	0
UR_2	5	0	5
UR_3	5	8	13
UR_4	0	0	0
Unrestricted Total	10	8	18

Table 10

Experiment 2 Aggregates

Condition	*n*	*Mdn*	95% CI[a]	Normal Dist.[B]	*U*	*p*	*d*
				Barrier Reveals			
Communication					1116	.794	0.05
Restricted	48	14.0	[9, 19]	No			
Unrestricted	48	18.0	[7, 33]	No			
Incentive Type					759	.004	0.62
Fixed	48	23.5	[12, 42]	No			
Individual	48	10.5	[5, 17]	No			
				Score			
Communication					1103	.719	0.07
Restricted	48	68.0	[63, 80]	Yes			
Unrestricted	48	74.0	[66, 81]	Yes			
Incentive Type					857.5	.031	0.45
Fixed	48	66.5	[54, 74]	Yes			
Individual	48	75.5	[68, 87]	Yes			

[a]95% confidence interval of the median. [b]D'Agostino-Pearson omnibus normality test ($\alpha = .05$).

Table 11

Experiment 2 Demand Parameters and Metrics

Curve	k	R^2	Q_0	α	EV	P_{max}	O_{max}
Communication							
Restricted	1.4	.98	9.0	.0270	0.224	1.90	5.19
Unrestricted	1.4	.99	8.3	.0210	0.287	2.65	6.68
Incentive Type							
Fixed	1.9	.99	10.0	.0100	0.382	3.08	9.66
Individual	1.9	.99	7.3	.0340	0.112	1.24	2.84
Communication x Incentive							
Restricted-Fixed	2.7	.99	9.8	.0080	0.282	2.51	8.10
Restricted-Individual	2.7	.96	7.5	.0210	0.107	1.25	3.09
Unrestricted-Fixed	2.7	.98	9.9	.0059	0.382	3.37	10.98
Unrestricted-Individual	2.7	.98	6.4	.0220	0.102	1.40	2.95
Shared Individual[a]	2.7	.97	6.9	.0220	0.102	1.30	2.95

[a]Single best-fit curve fitting Restricted-Individual and Unrestricted-Individual data.

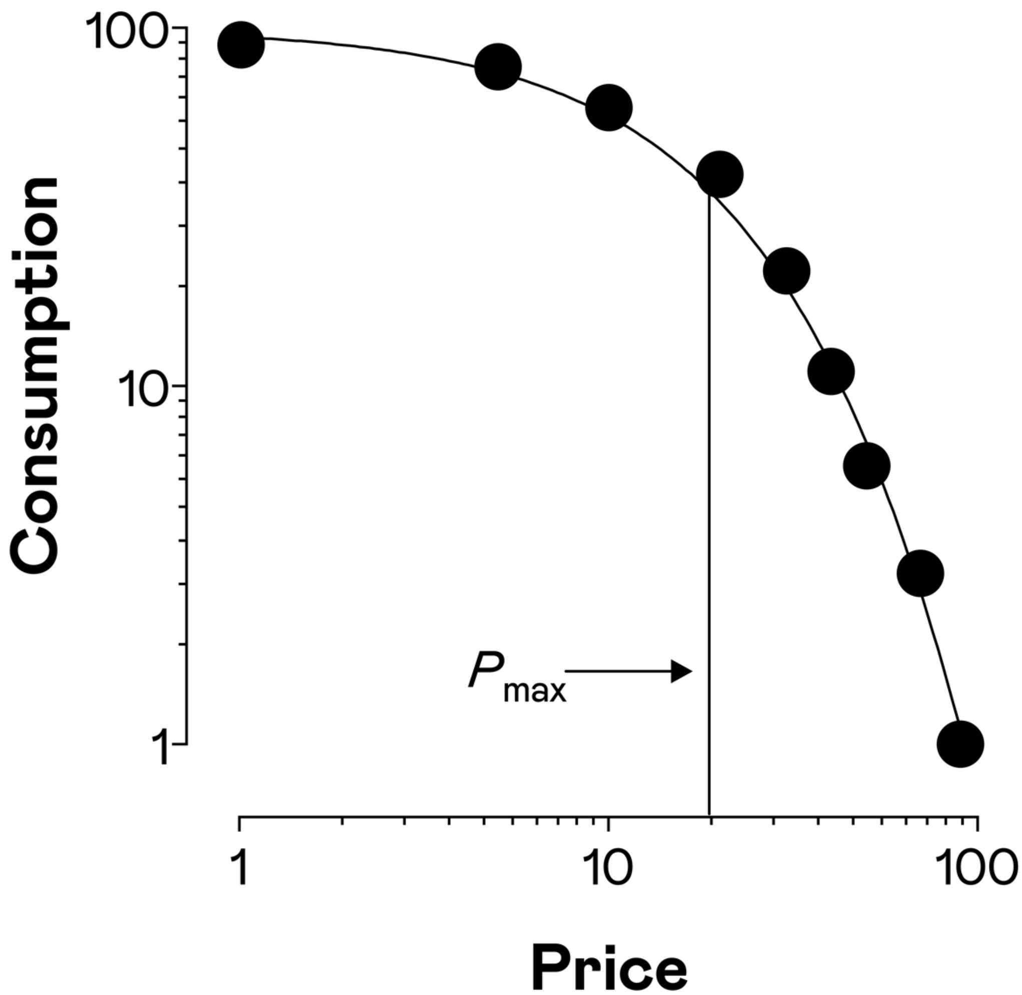


Figure 1. Sample demand curve.

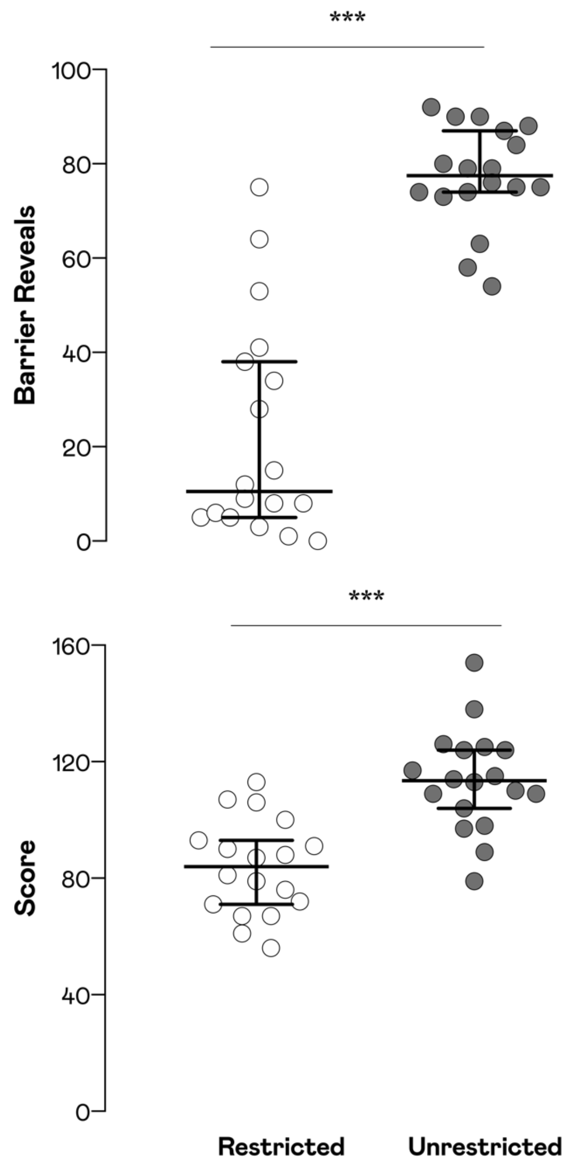


Figure 2. Experiment 1 trial totals with bars indicating median and 95% confidence interval (CI) of median for restricted and unrestricted conditions. The y-axes depict total barrier reveals (top panel) and score (bottom panel). ***$p < .001$.

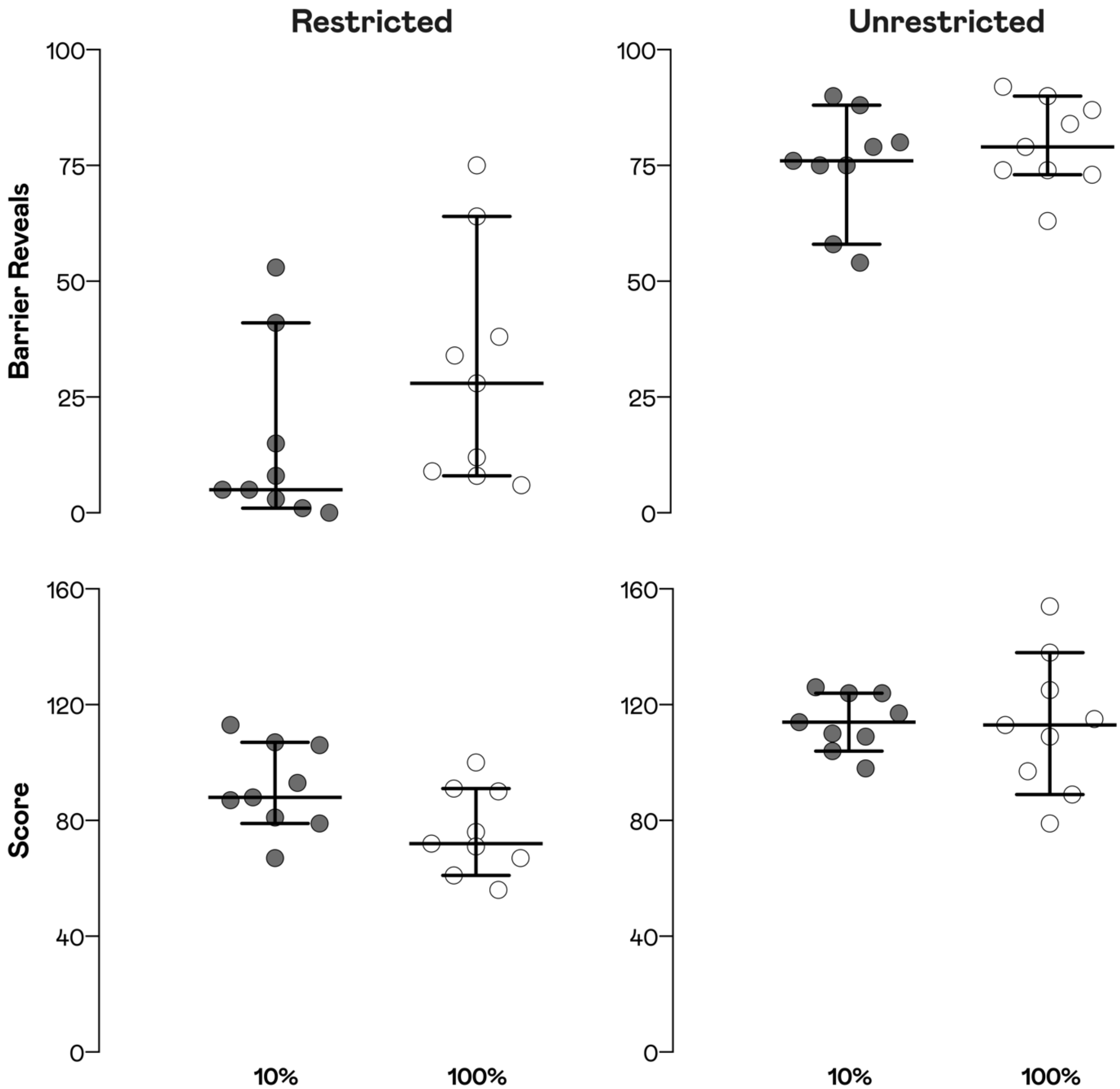


Figure 3. Experiment 1 trial totals with bars indicating median and 95% CI of median for restricted (left panels) and unrestricted (right panels) teams in the 10% and 100% conditions. The y-axes depict total barrier reveals (top panels) and score (bottom panels).

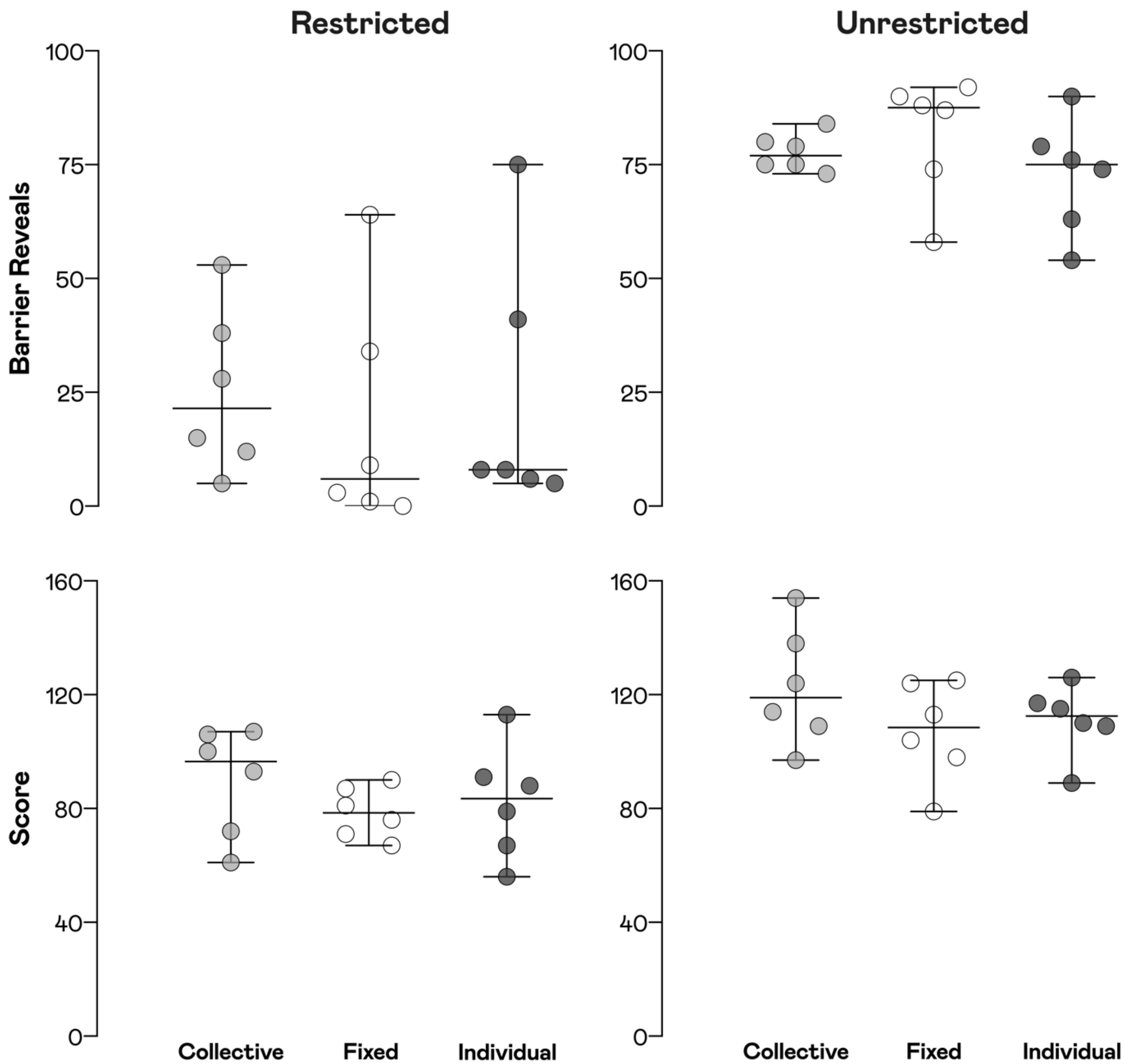


Figure 4. Experiment 1 trial totals and with bars indicating median and 95% CI of median for the restricted (left panels) and unrestricted (right panels) teams in the collective, fixed, and individual conditions. The y-axes depict total barrier reveals (top panels) and score (bottom panels).

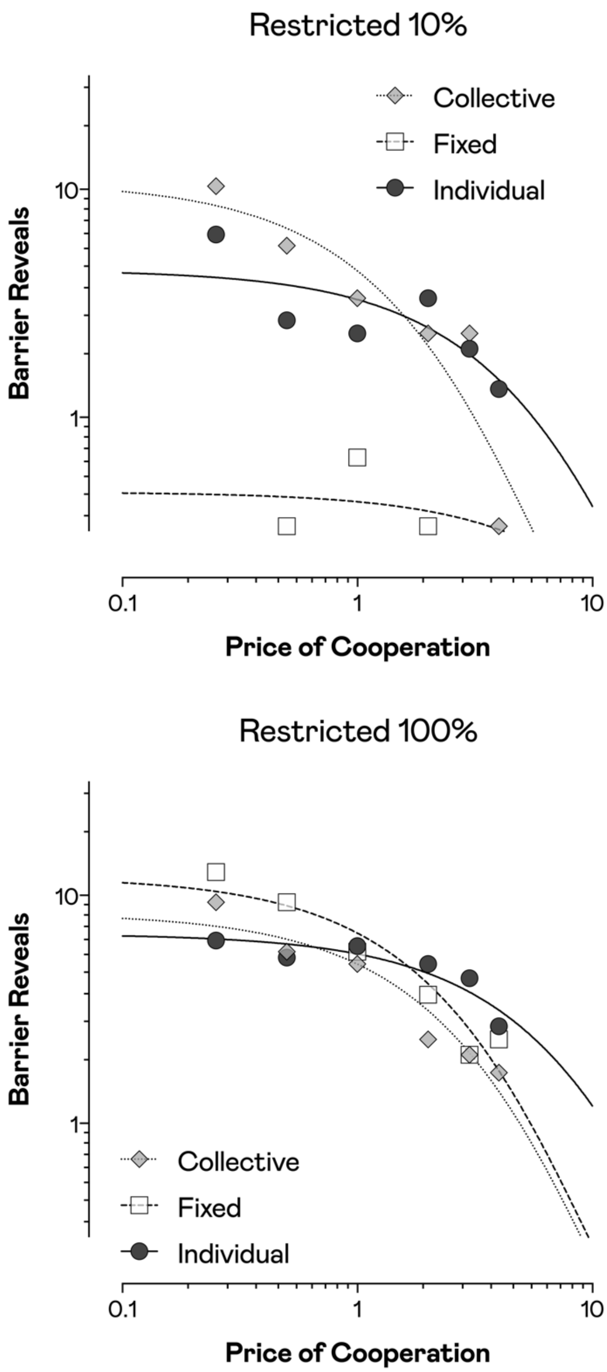


Figure 5. Experiment 1 mean barrier reveals at each price of cooperation with best-fit demand curves for each incentive type in the 10% (top panel) and 100% (bottom panel) conditions for the restricted team. (Note: No error data or derived measures are depicted due to small sample size).

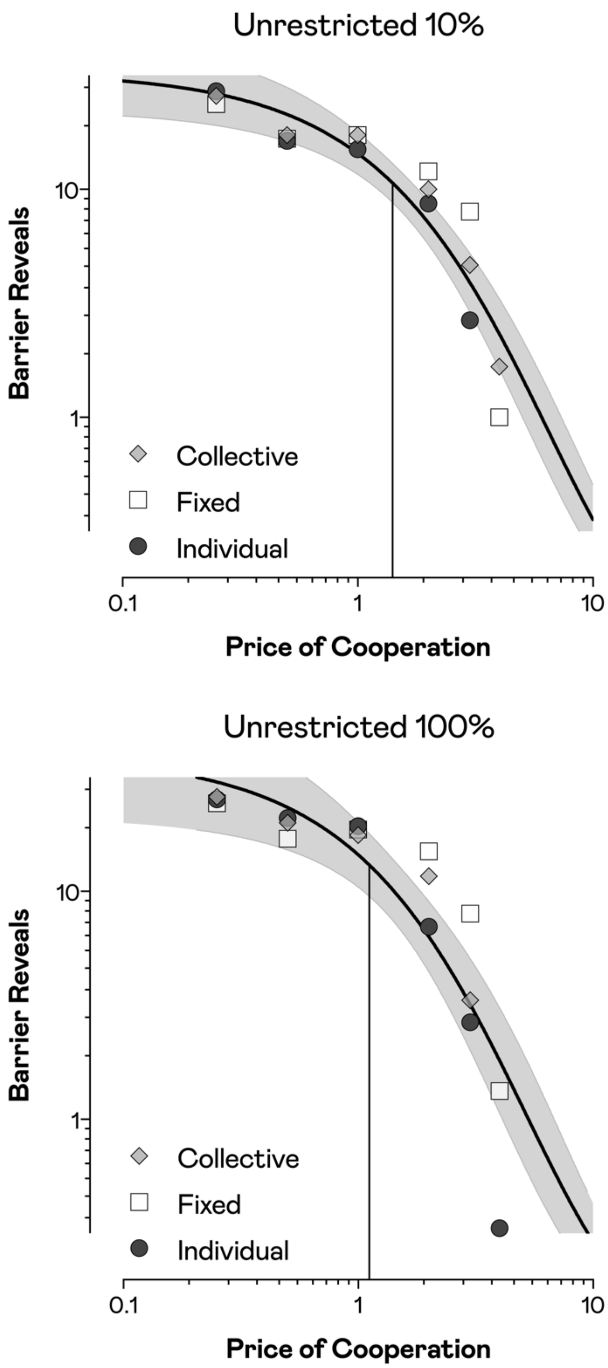


Figure 6. Experiment 1 mean barrier reveals at each price of cooperation with aggregate shared best-fit demand curves (and shaded 95% confidence bands) in the 10% (top panel) and 100% (bottom panel) conditions for the unrestricted team. Vertical lines correspond to derived P_{max} for each shared curve.

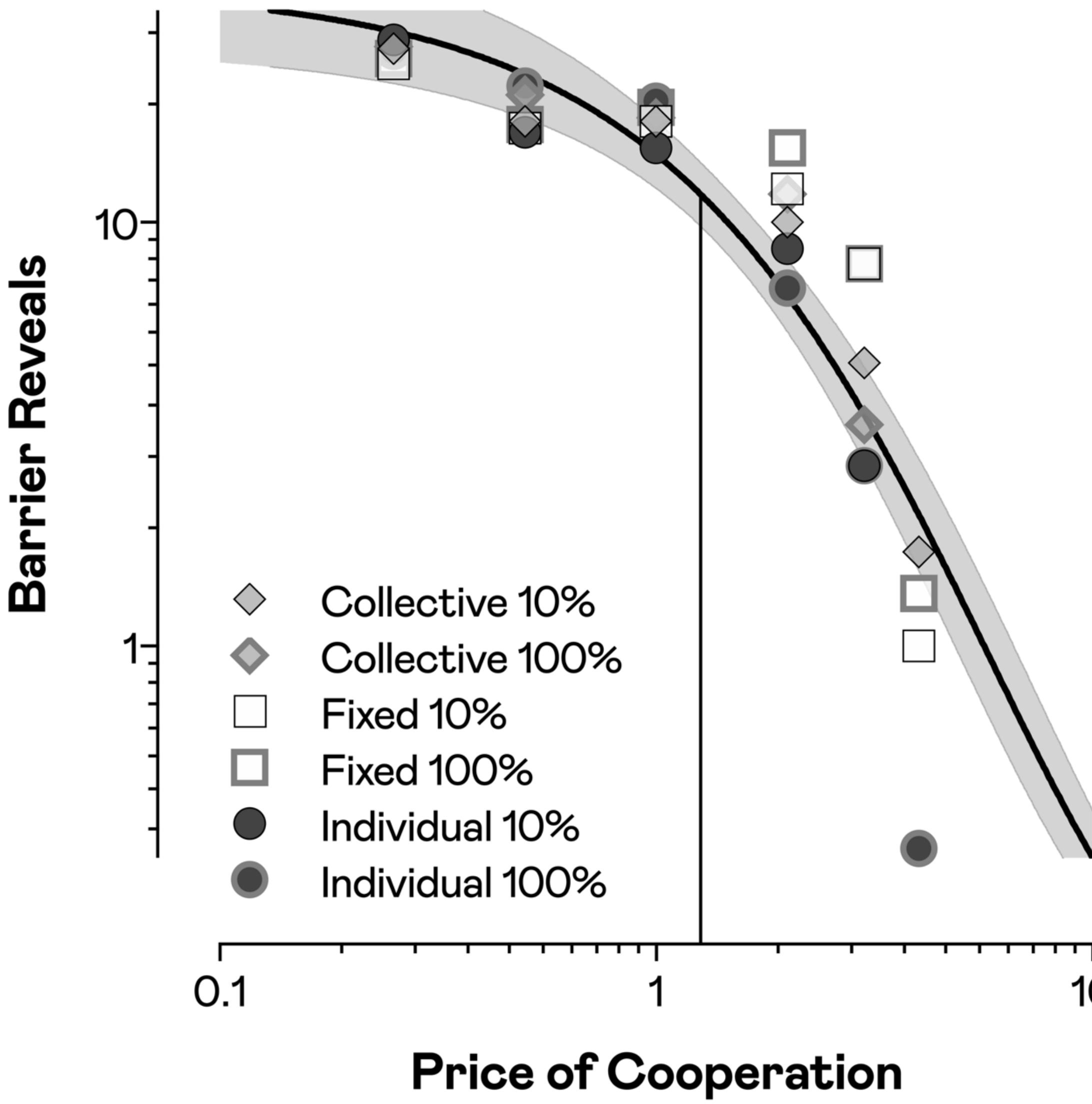


Figure 7. Experiment 1 mean barrier reveals at each price of cooperation with aggregate shared best-fit demand curve (and shaded 95% confidence band) for the unrestricted team under all incentive conditions. The vertical line corresponds to derived P_{max}.

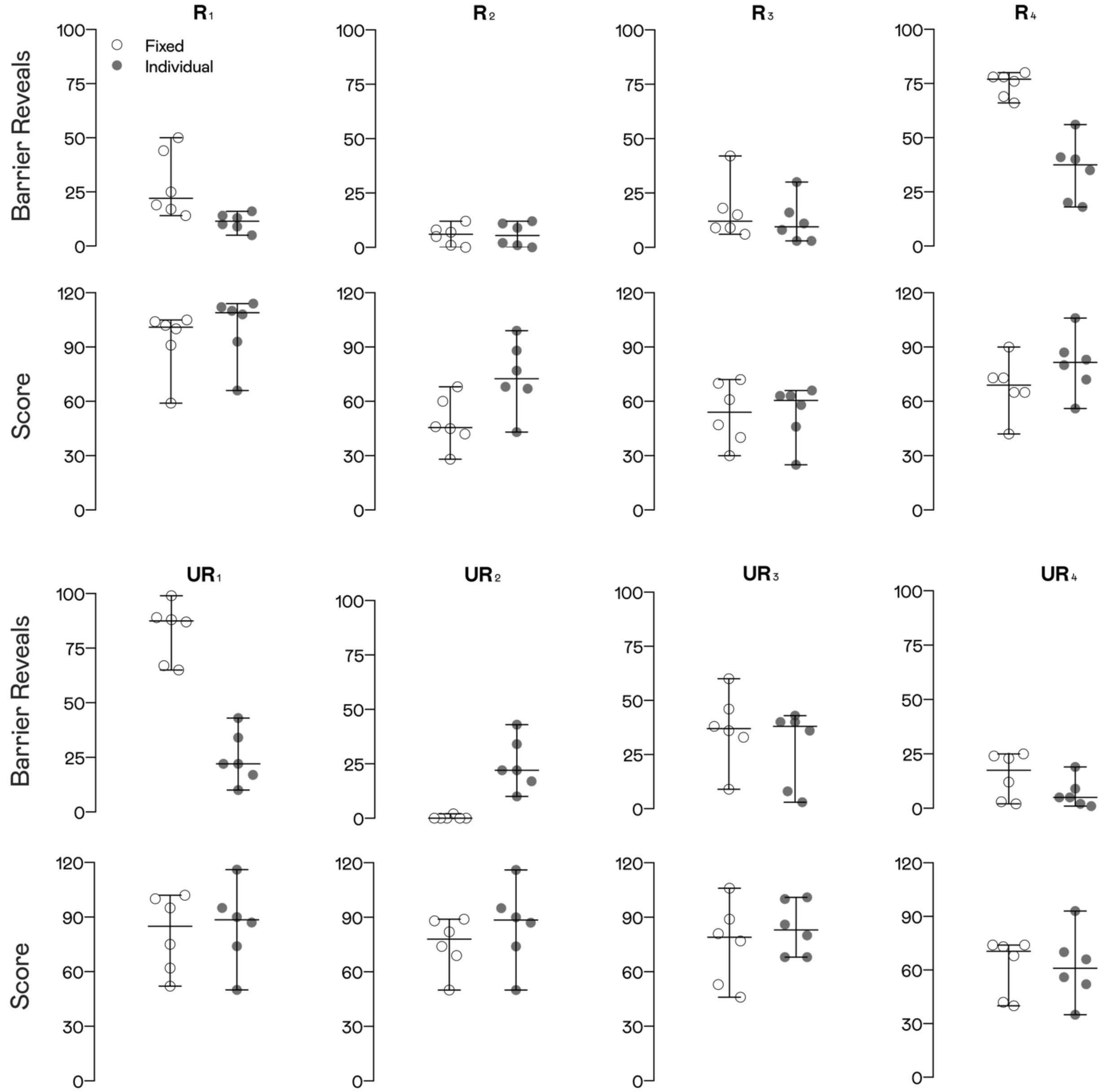


Figure 8. Experiment 2 trial totals with bars indicating median and 95% CI of median for fixed and individual conditions across all teams. Teams R_1-R_4 are on the top half, teams UR_1-UR_4 are on the bottom half. The y-axes depict total barrier reveals (rows 1 and 3) and score (rows 2 and 4).

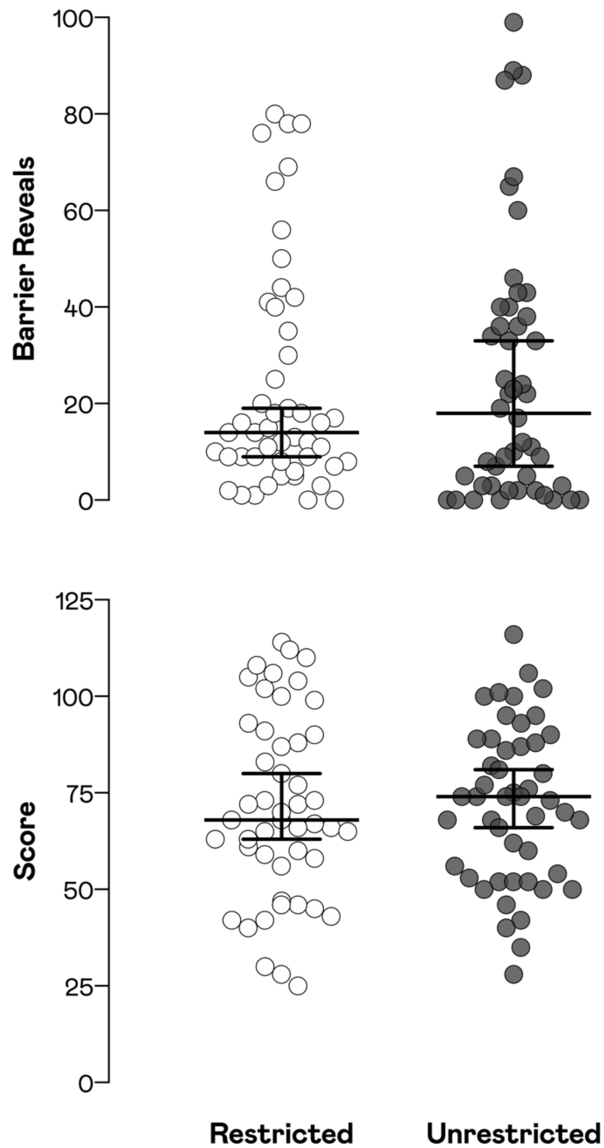


Figure 9. Experiment 2 trial totals with bars indicating median and 95% CI of median for all teams in the restricted and unrestricted conditions. The y-axes depict total barrier reveals (top panel) and score (bottom panel).

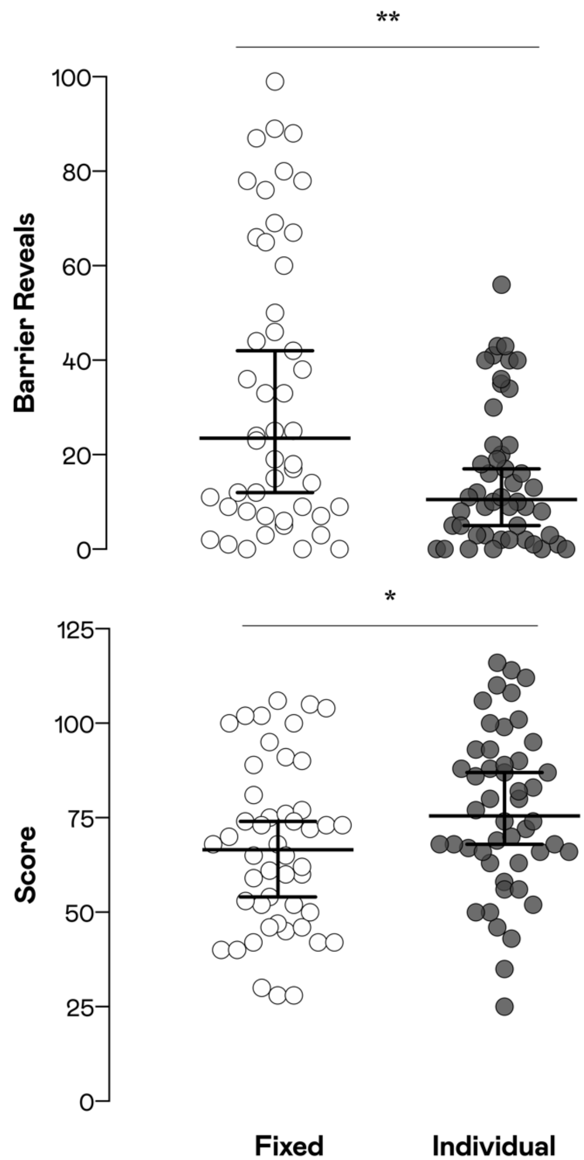


Figure 10. Experiment 2 trial totals with bars indicating median and 95% CI of median for all teams in fixed and individual conditions. The y-axes depict team total barrier reveals (top panel) and score (bottom panel). **p* < .05, ***p* < .01.

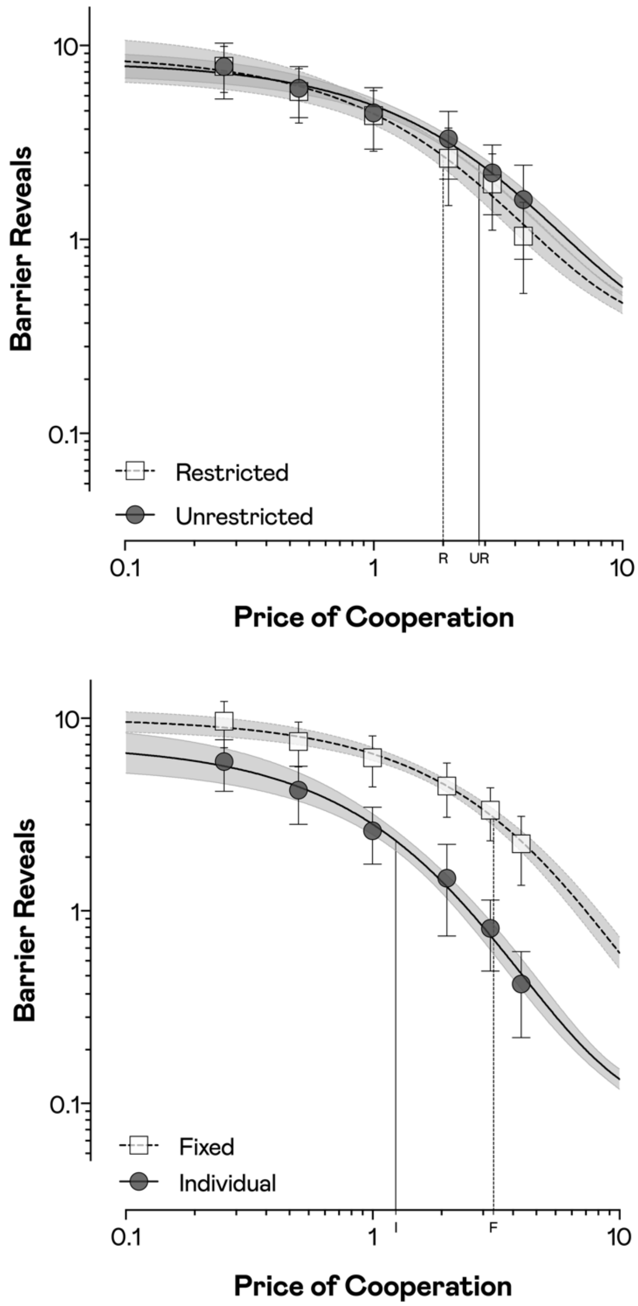


Figure 11. Experiment 2 mean (and 95% CI of *M*) barrier reveals at each price of cooperation with best-fit demand curves (and shaded 95% confidence bands) for the restricted and unrestricted (top panel) and fixed and individual (bottom panel) conditions. Vertical lines correspond to derived P_{max} for each condition.

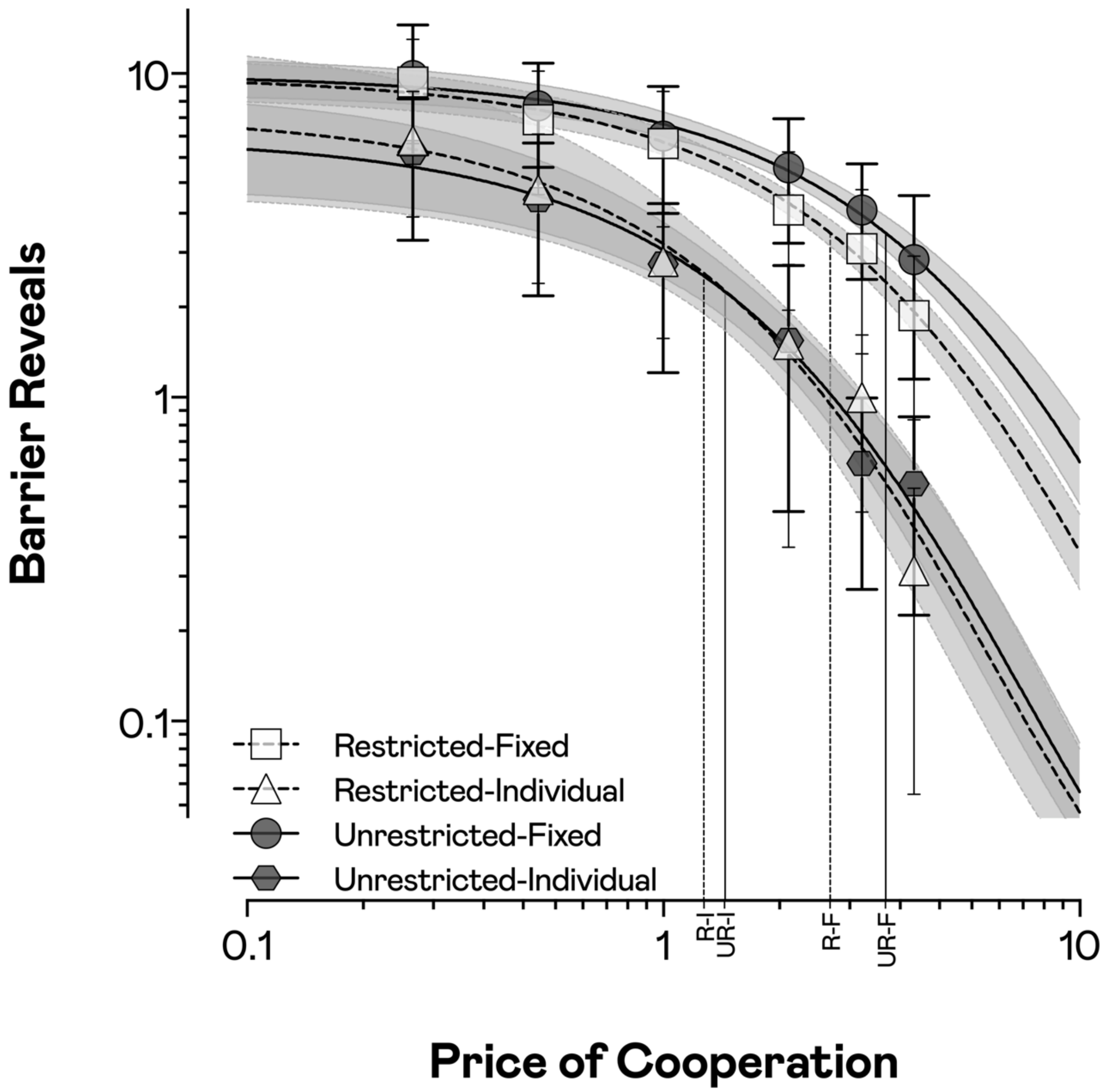


Figure 12. Experiment 2 mean (and 95% CI of *M*) barrier reveals at each price of cooperation with best-fit demand curves (and shaded 95% confidence bands) for each condition combination. Vertical lines correspond to derived P_{max} for each condition.

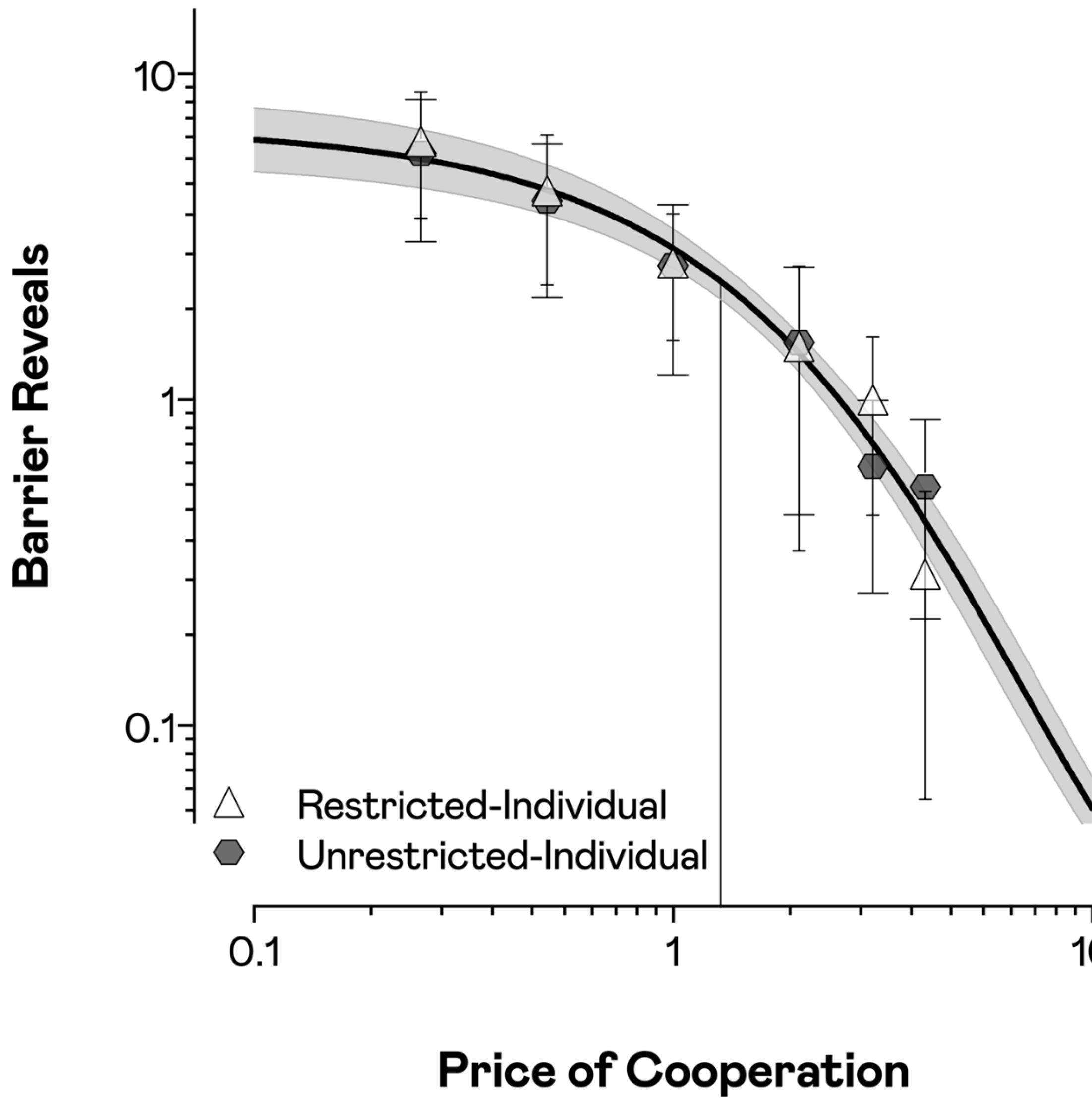


Figure 13. Experiment 2 mean (and 95% CI of *M*) barrier reveals at each price of cooperation with aggregate shared best-fit demand curve (and shaded 95% confidence bands) for restricted- and unrestricted-individual conditions. The vertical line corresponds to derived P_{max}.

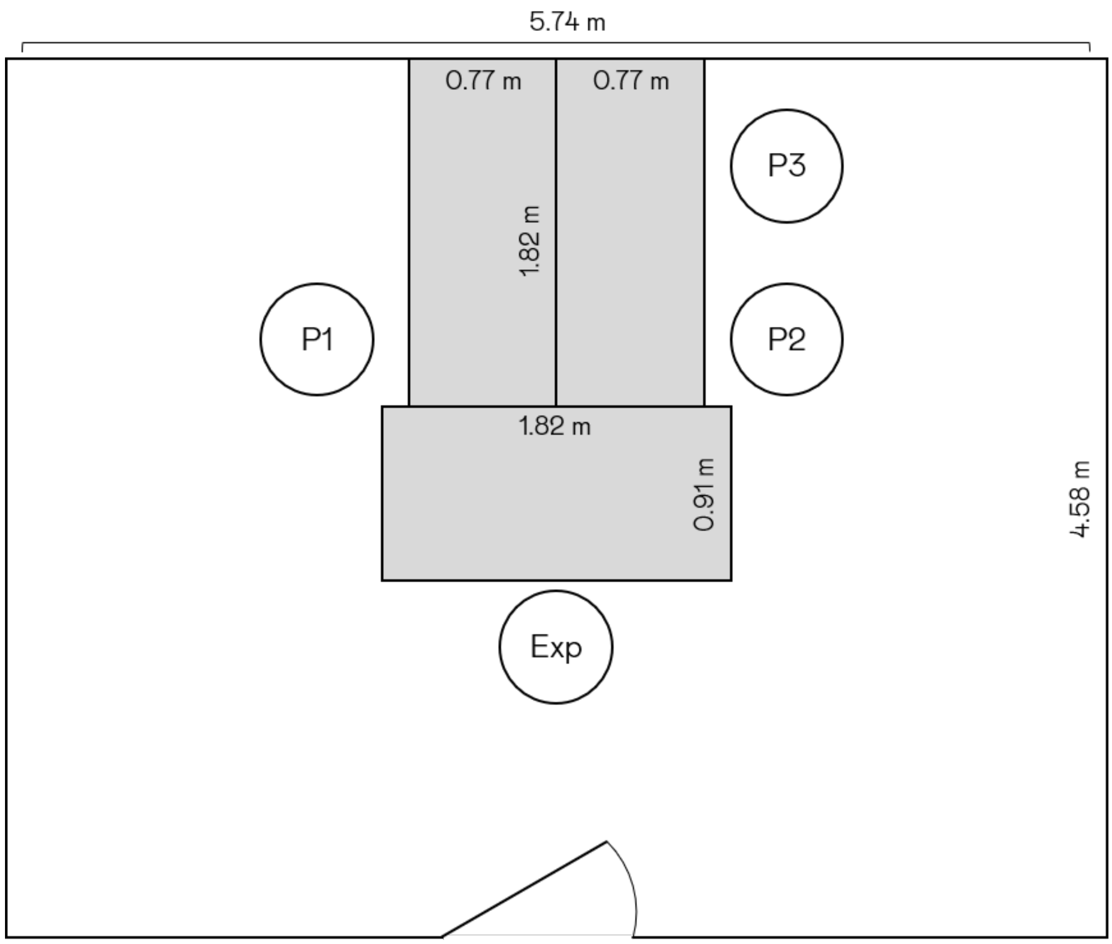
Appendix A

Participant recruitment script.

> "The purpose of the study is to evaluate the effects of several incentive systems on your performance on a group work task. Participants will be asked to complete a game for 3 minutes at a time, for one 90-minute visit to our lab. Sessions will consist of three participants completing the game at the same time and in the same room. During the course of the study, you will be exposed to a variety of incentive arrangements. In exchange for participation, participants will be paid $10 for attending plus any incentives they earn during the course of the study. In order to be eligible to participate, you must be 18 years of age or older."

Appendix B

Session room arrangement.

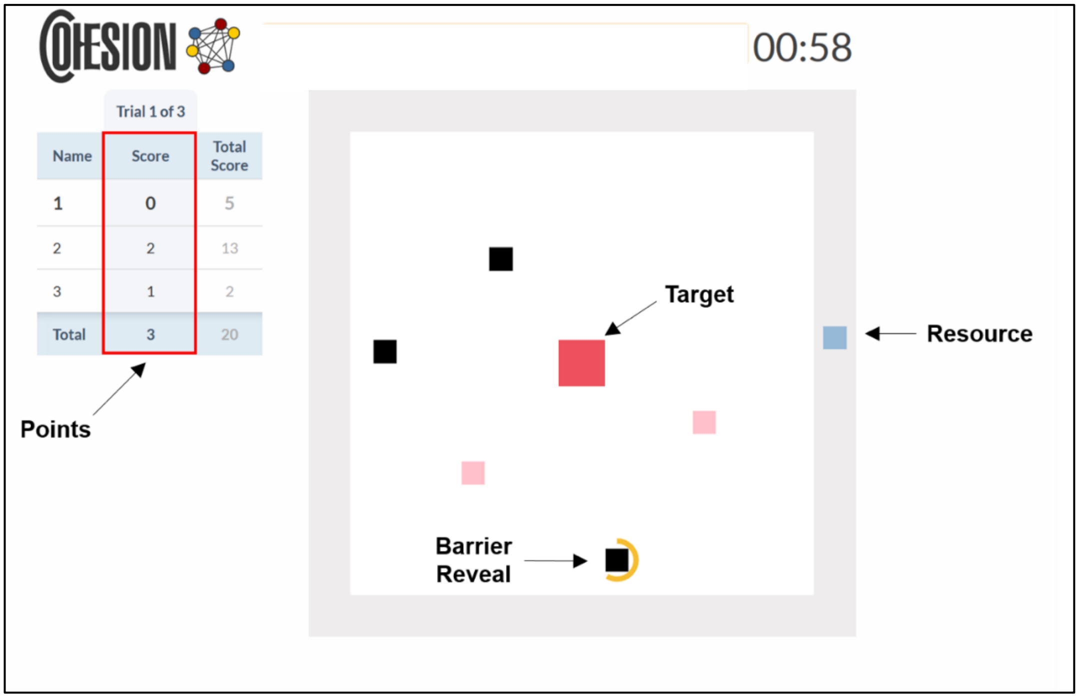


Note: Shaded rectangles represent tables, circles indicate where each participant was seated.

Exp=experimenter; P1=participant 1; P2=participant 2; P3=participant 3.

Appendix C

Screenshot of the COHESION Gameplay.



Note: Labels are added to indicate a *resource*, *barrier reveal, target zone,* and score panel with *points.* Barriers that appear black are not visible to teammates. The yellow circle indicates that the barrier is in the process of being revealed; once revealed barriers will turn pink. Time remaining in the trial appears at the top right of the screen.

Appendix D

Experiment 1 trial orders.

Trial	Probability	Incentive Type	
		Restricted	Unrestricted
1	100	Individual	Fixed
2		Collective	Collective
3		Fixed	Individual
4	10	Individual	Fixed
5		Collective	Collective
6		Fixed	Individual
7	100	Individual	Fixed
8		Fixed	Individual
9		Collective	Collective
10	10	Individual	Fixed
11		Fixed	Individual
12		Collective	Collective
13	100	Collective	Collective
14		Individual	Fixed
15		Fixed	Individual
16	10	Collective	Collective
17		Individual	Fixed
18		Fixed	Individual

Appendix E

Informed consent form.

Informed Consent Statement

Effects of Probabilistic Incentive Systems on Performance

INTRODUCTION

The Department of Applied Behavioral Science at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

PURPOSE OF THE STUDY

The purpose of the present study is to evaluate the effects of several incentive systems on performance.

PROCEDURES

During the study, you will be given the opportunity to complete a task involving a game known as "Cohesion." Throughout the experiment, you may choose to participate in the task or not. The task will be presented for three to six minutes at a time, at the beginning of which the experimenter will describe the details of the incentive system in place for those three to six minutes. Participants will be asked to complete approximately twelve blocks lasting for 90-120 minutes. In addition, participants will be asked to complete a brief demographic survey and debriefing questionnaire at the conclusion of the study.

In exchange for participation, monetary compensation will be provided. Participants will be paid $10 for attending the session. In addition, they will earn incentive payments according to the conditions in place as described by the experimenter at the beginning of each session. Participants may earn $2/block if they are eligible (meet performance criterion) and earn the incentive after applying the probability. Participants may earn a maximum of $34/session.

Sessions may be recorded. Video recordings will be used by the research team solely for the purposes of collecting data and the recordings will not be made available to anyone other than the research team. The files will be help securely in electronic format on a secure server to which only the research team has access and will be destroyed after a maximum of two years.

RISKS

There are no risks associated with participation in this study.

BENEFITS

There are no direct benefits to participants. The present study will contribute to the literature base on characteristics of effective incentive systems and will benefit managers in organizational settings by informing practice in effective performance management.

KU Lawrence IRB # STUDY00003940 | Approval Period 3/3/2017 – 3/31/2018

PAYMENT TO PARTICIPANTS

Participants accrue incentive payments by meeting the criteria of the incentive system described by the experimenter at the beginning of each 6-minute session. Payment will be made in lump sum at the conclusion of the study through the ClinCard (which can be used like a credit card). Investigators will ask for your social security number in order to comply with federal and state tax and accounting regulations. This will be done when your register the card and the investigators will not have access to this information.

PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form, you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: Florence D. DiGennaro Reed, 4020 Dole, 1000 Sunnyside Avenue, Lawrence, KS 66045.

If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email irb@ku.edu.

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

_______________________________ _____________________

Print Participant's Name Date

____

Participant's Signature

Researcher Contact Information

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KU Lawrence IRB # STUDY00003940 | Approval Period 3/3/2017 – 3/31/2018

Appendix F

Demographic questionnaire.

Demographic Questionnaire

ID # (given to you by researcher): ___________
Do NOT enter your student ID number!

Age: _________

Gender:
- ◯ Male
- ◯ Female

Race/ethnic background:
- ◯ White/Caucasian
- ◯ Black/African American
- ◯ Hispanic/Latino
- ◯ Asian
- ◯ Native American
- ◯ Pacific Islander
- ◯ Biracial/Multiracial
- ◯ Other

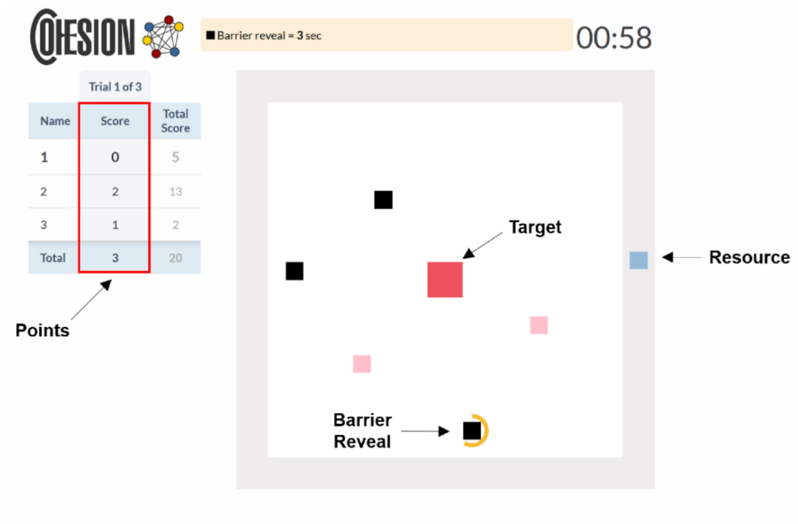
Do you have a DOCUMENTED disability?
- ◯ Yes
- ◯ No

If yes, please specify:
- ◯ Learning disability
- ◯ Attention deficit/hyperactivity disorder
- ◯ Physical disability
- ◯ Other

Is English your first/primary language?
- ◯ Yes
- ◯ No

Appendix G

COHESION gameplay information sheet.



Incentive Types

Fixed: Each group member earns $1.00, regardless of performance.

Individual: Each group member earns $0.10 per point scored.

Collective: Group earns $0.10 per total points scored and earnings are distributed equally amongst all members.

Probabilities

100%: Die roll must be between 1 – 20

10%: Die roll must be between 1 – 2

Note: For Experiment 2, participants received this document with *collective incentive* and *probabilities* sections removed.

Appendix H

Sample participant in-session tracking log.

COHESION

Group #:_______ Participant #:_____ Date:_________

Block	Percent	Condition	Trial	Bonus
1	100	Fixed	1	$
		Collective	2	$
		Individual	3	$
2	10	Fixed	4	$
		Collective	5	$
		Individual	6	$
3	100	Fixed	7	$
		Individual	8	$
		Collective	9	$
4	10	Fixed	10	$
		Individual	11	$
		Collective	12	$
5	100	Collective	13	$
		Fixed	14	$
		Individual	15	$
6	10	Collective	16	$
		Fixed	17	$
		Individual	18	$

Note: Participants in Experiment 2 received a tracking log that was similar but without the percent section and with only 12 trials.

Appendix I

Debrief questionnaire.

Debrief

1. How clear were the instructions you received to perform the Cohesion task?

   Very Clear
   Moderately Clear
   Minimally Clear
   Not Clear

2. What improvements could be made to the instructions of the Cohesion task to increase your understanding of the task?

3. How clear were the instructions you received on the performance criterion required to earn incentives?

   Very Clear
   Moderately Clear
   Minimally Clear
   Not Clear

4. What improvements could be made to the instructions of the performance criterion to increase your understanding of the requirements to earn incentives?

5. What was your impression of the Cohesion task?

6. Do you have any other sources of income? If yes, please identify the source (e.g. employment, student loans, access to guardian's finances).

Appendix J

Experiment 2 trial orders.

Trial	Restricted				Unrestricted			
	R_1	R_2	R_3	R_4	UR_1	UR_2	UR_3	UR_4
1	Individual	Fixed	Individual	Fixed	Individual	Individual	Fixed	Fixed
2	Fixed	Individual	Fixed	Individual	Fixed	Fixed	Individual	Individual
3	Fixed	Individual	Individual	Individual	Individual	Individual	Individual	Fixed
4	Individual	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Individual
5	Fixed	Individual	Fixed	Fixed	Fixed	Fixed	Fixed	Individual
6	Individual	Fixed	Individual	Individual	Individual	Individual	Individual	Fixed
7	Fixed	Individual	Fixed	Individual	Individual	Fixed	Individual	Fixed
8	Individual	Fixed	Individual	Fixed	Fixed	Individual	Fixed	Individual
9	Individual	Fixed	Fixed	Fixed	Individual	Individual	Individual	Fixed
10	Fixed	Individual	Individual	Individual	Fixed	Fixed	Fixed	Individual
11	Individual	Individual	Individual	Individual	Fixed	Individual	Fixed	Individual
12	Fixed	Fixed	Fixed	Fixed	Individual	Fixed	Individual	Fixed

Appendix K

Sample procedural integrity and communication data sheet.

COHESION

Date:
Team #:
Experimenter:
Fidelity Scorer:

			Pre Trial	Communication		Post-Trial	
Block	**Condition**	**Trial**	**Condition Type**	**Pre-Trial**	**Within-Trial**	**Condition Type**	**Incentive Amount**
1	Fixed	1	Y N	R O N	R O N	Y N	Y N
	Individual	2	Y N	R O N	R O N	Y N	Y N
	Fixed	3	Y N	R O N	R O N	Y N	Y N
	Individual	4	Y N	R O N	R O N	Y N	Y N
2	Individual	5	Y N	R O N	R O N	Y N	Y N
	Fixed	6	Y N	R O N	R O N	Y N	Y N
	Fixed	7	Y N	R O N	R O N	Y N	Y N
	Individual	8	Y N	R O N	R O N	Y N	Y N
3	Fixed	9	Y N	R O N	R O N	Y N	Y N
	Individual	10	Y N	R O N	R O N	Y N	Y N
	Individual	11	Y N	R O N	R O N	Y N	Y N
	Fixed	12	Y N	R O N	R O N	Y N	Y N

R = Relevent
O = Off-topic
N = No communication