Social Behaviour. Vol. 5, 261–284 (1990)

Avoiding Social Traps: Some Conditions that Maintain Adherence to Restricted Consumption

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ABSTRACT

Two experiments were conducted at a large southwestern US university. In these studies all experimental subjects were informed of the optimum solution to a social trap analogue confronting groups of four persons. The effectiveness with which this solution was implemented was the dependent variable. Incentives for differential rates of responding, and two levels each of commitment, participation, and surveillance were the manipulated independent variables. Strikingly large effects were found showing that the experimental groups performed much better than control groups who had not been informed of the solution, and that the implementation of a solution is greatly affected by the group decision-making process. Discussion focused on the translation of these experimental manipulations into group process techniques for application to social dilemmas in natural settings.

Key words: Social traps, commons dilemmas, group decision-making, intervention strategies.

Social dilemmas, commons dilemmas and social traps, despite the structural differences among them, all present individuals with a choice between maximizing personal gain or contributing to group welfare. Because persons will generally choose self-benefit over group benefit, these dilemmas prove to be, by their very nature, particularly difficult situations to remedy.

The depletion of the earth's protective ozone layer and more localized urban air pollution are two timely and salient examples of such situations. Both clearly present individuals with choices where personal self-gratification is at odds with the public and even humankind's welfare. In the case of global ozone depletion, atmospheric scientists have warned us that this protective layer surrounding the earth is annually diminished, due mainly to the action of airborne chlorofluorocarbons. They have admonished us, therefore, to: discontinue using styrofoams completely, have our home and motor-car air-conditioning systems inspected annually for leaks, cease using aerosol sprays which employ chlorofluorocarbons as propellants, etc. However, despite their clear and simple-to-follow instructions, it is apparent that styrofoam cups and plates continue to be used, and air-conditioning specialists are not back-

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0885–6249/90/040261–24$12.00

logged with requests for home inspections. Generally, then, it seems people are not willing to inconvenience themselves, even a little bit, for a situation of such magnitude. Perhaps it is because they do not presently and directly experience the effects of their behaviour.

Surely, therefore, in instances where they can see the negative consequences of their actions, people would change their behaviours. For example, the air pollution which plagues cities such as Los Angeles year-round, and Phoenix in the winter, is obvious to the naked eye and highly salient even to the most unscientific observer. In these cities the air is often so tainted that the populace is warned not to go outside unless they absolutely must. Public service announcements and news broadcasts admonish the citizenry to use public transportation, to share car trips and to combine errands into one trip. These recommendations are all in an effort to provide reasonable strategies to alleviate the unhealthy haze infiltrating these cities. Do the citizens follow these admonitions? No. Instead they generally pursue their usual, more personally convenient, air-polluting behaviour patterns.

It is the short-term, self-accruing benefit individuals experience which drives such societally dysfunctional behaviours—despite reasonable, albeit somewhat inconvenient, solutions. The intransigence of these behaviour patterns is what motivates social traps researchers to investigate interventions which can successfully ameliorate the negative, long-term impact such contingencies produce in a world of limited resources.

It is evident that the resolution of these dilemmas always depend on reducing the frequency/intensity of the self-benefiting response for a sufficiently large proportion of the participants so that the public good is produced or the public bad is avoided (Linder, 1982). However, the effectiveness of interventions designed to reduce the frequency/intensity of the selfish response is difficult to assess in the naturally occurring dilemmas that surround us in the late twentieth century. This difficulty has given rise to the development of numerous laboratory analogues designed to reproduce the conflict between self-benefit and group benefit (e.g. Brechner, 1977; Edney, 1979).

The experiments reported in this article used a computer-driven social trap analogue in which the selfish response was harvesting the maximum number of points on each trial, and the group-benefiting response was to harvest at a slow rate, allowing the pool of points (the commons) to replenish fully after each trial. Thus, the target response for all of the interventions used in these experiments was the number of points requested by each individual on each trial. Because the goal of this research was to identify potentially effective interventions for dilemmas and traps in our society, the choice of the number of points to harvest was not made analogous to any particular, naturally occurring situation. Instead, points were valuable to the individual, but if they were too rapidly harvested the pool would be depleted and all participants would be deprived of any further gain. It was our hope that this almost generic dilemma would allow generalization to a wide range of situations.

INTERVENTION TYPOLOGIES

Linder (1982) has proposed that interventions designed to solve these dilemmas fall into three classes: behavioural, cognitive and social-structural. We believe that this categorization is somewhat limited, and propose instead that solutions may be charac-

terized as having behaviourist, cognitive, and social-structural components. These components affect the contingencies of reinforcement acting on individuals, the knowledge available to them, and the structure of the social situation they confront, respectively. Thus an intervention need not be classified into one of a set of mutually exclusive categories. Rather, any proposed intervention can be assessed according to the multidimensional properties it actually has. A typology of interventions may emerge when enough of them have been evaluated in research designed to explore them systematically, varying the properties of the interventions in factorial combinations. The experiments to be reported in this article feature such factorial combinations, rather than being focused on interventions selected from discrete classes.

Unfortunately, Yamagishi (1986) has used the term 'structural' to refer to what we have labelled as the behaviourist aspects of interventions, but he also includes privatization and leadership within this category. Messick and Brewer (1983) have proposed yet another partitioning of interventions, based primarily on a distinction between influences on individual choice, and their category of structural changes, which differs from Yamagishi's (1986). While we regret any confusion caused by different usage among different authors, we believe that our system allows a clear exposition and analysis of proposed solutions, and we will attempt to use it consistently in this article.

The behavioural component

The behavioural component of any intervention is the extent to which it changes the contingencies of reinforcement that act upon users of the common resource, or members of the community of responding organisms, as in the case of a social trap. Platt's (1973) analysis of the social trap from a behaviourist perspective suggests that interventions focused on changing the payoffs for consumption and conservation will be effective. Surprisingly, there are few studies of commons dilemmas and social traps in which payoffs have been explicitly manipulated, although there are many studies of two or *n*-person prisoner's dilemma games that show enhanced cooperation when payoffs are appropriately restructured (see Dawes, 1980; Messick and Brewer, 1983; Yamagishi, 1986, for reviews).

There are several ways in which contingencies may be changed to reduce the frequency/intensity of the consummatory response in commons dilemmas. First, the incentive value of the resource itself may be reduced. However, in many naturally occurring situations—involving whale, elephant, and gorilla products, for example—the resource becomes ever more valuable as it is depleted. In addition, the value of the resource may be set by market forces beyond the control of any intervenor. A second possibility is punishment for overconsumption. Bell, Petersen and Hautaluoma (1990) manipulated the probability of punishment for overconsumption in a commons dilemma analogue and found that a higher probability of punishment was associated with decreased overconsumption and preservation of the commons. However, if it was possible to steal from other commons users, punishment for overconsumption made stealing more likely. Still, the commons was more likely to be preserved. A third option, and one recommended by Platt (1973), is to put into effect new contingencies which reward behaviour that is incompatible with rapid, personal consumption of the resource. A bonus system that provides rewards for low levels of consumption is one such contingency. These types of incentive systems have been tried in applied research on energy conservation (McClelland and Cook, 1980; Selig-

man and Darley, 1977; Walker, 1979), but more research is needed to assess the modifiability of behaviour in laboratory analogues of commons dilemmas by means of reinforcement of alternative responses. Thus Experiment 1 included an explicit manipulation of an incentive for slow, steady harvesting of the common pool resource.

The cognitive component

The cognitive component of interventions in commons dilemmas and social traps refers, principally, to the knowledge about the situation which is made available to the participants by the intervening agent. Hardin (1968) argued that information alone would not change behaviour and avert the tragedy of the commons. Nevertheless, many investigators have provided participants with information about the nature of the commons problem (Stern, 1976; Edney and Bell, 1983), or fairly explicit directions about an optimal, cooperative strategy (Edney and Harper, 1978b; Schroeder, Jensen, Reed, Sullivan and Schwab, 1983). The results of these studies have been quite mixed. In some (Stern, 1976; Schroeder *et al.*, 1983) information has led to higher levels of cooperation. In others, information alone has not increased cooperative responding significantly beyond control levels. However, when combined with the opportunity to communicate with other users, knowledge of the optimal strategy has significantly affected resource conservation (Edney and Harper, 1978b). Even when explicit information about an optimizing strategy has been made available to the users of a commons, the harvesting behaviour of the groups has been suboptimal. Resource pools are usually maintained at low levels, and the harvest has been well below the level attainable by consistent application of the optimizing response pattern.

Prior experience with the resource pool has also been shown to lead to improved performance (Allison and Messick, 1985), but only when the prior experience has been acquired by individuals who then become members of six-person rather than three-person groups. Thus, while information may have some impact on the harvesting behaviour of users of a commons, it does not always lead to significant changes, and does not produce an optimal response pattern. Of course, many interventions other than the provision of information or experience have cognitive components. Changes in the reinforcement contingencies governing a commons dilemma, and changes in the social structure of the situation, will have social cognition effects on the community of users. It is the combination of social-structural change and their concomitant cognitive effects that may have the greatest impact on behaviour in commons dilemmas and social traps.

The social-structural component

Social-structural interventions modify the situation in which a commons dilemma is embedded. The intervention can range from the simple provision of the opportunity to communicate (Brechner, 1977), to the implementation of a leadership structure and rules for decision-making (Shippee, 1978), to privatization or communization of the commons (Cass, 1975; Edney and Harper, 1978b). It is generally agreed that communication among the users of a commons facilitates cooperative responding (Dawes, 1980; Messick and Brewer, 1983; Yamagishi, 1986). Yet communication can take many forms, ranging from simple warnings that the resource is about to be depleted (Brechner, 1977) to extended discussion of group strategies and individual

promises (Dawes, McTavish and Shaklee, 1977; Orbell, van de Kragt and Dawes, 1988). Orbell *et al.* (1988) provide evidence that cooperation is the result of making promises to cooperate during group discussion. When it is perceived that everyone has promised to cooperate, cooperation, in fact, ensues.

Kerr (1990) has reviewed these studies from the perspective of normative influences on individual behaviour. He proposed that a 'commitment norm' is made salient in these interactions, and has the effect of increasing the extent to which persons behave in accord with promises (commitments) they have made to other participants. Commitment, in a variety of forms, has been shown to have powerful effects on the behaviour of individuals. Although Bennett (1955) found that public commitment did not increase compliance beyond the level elicited by being asked to make a decision, and perceiving that there was a group consensus in support of the recommended individual action, subsequent research has provided support for the efficacy of commitment manipulations (Kiesler, 1971). In addition, Sensenig and Cialdini (1982) have shown that individual behaviour change is most likely to occur when individuals perceive their commitments to be active, effortful, public and internally generated. Because negative consequences occur in social traps and commons dilemmas as a result of the accumulation of individual actions, commitment by individuals to an agreed-upon, group outcome optimizing plan could lead to the resolution of the dilemma, or escape from the trap.

Orbell *et al.* (1988) have demonstrated the efficacy of group discussion and the resulting promises in a one-trial, 'give-some' game. Our interest was in whether commitments would be durable over a large number of trials in a replenishing resource dilemma. Our experiments, therefore, explored the efficacy of an explicit commitment to a group harvesting plan as a resource maintaining intervention in a commons dilemma.

SUMMARY AND HYPOTHESES

Experiment 1 was designed to test the effectiveness of a reinforcement contingency that encouraged slow, steady harvesting (the behavioural component of the intervention), and the effectiveness of an explicit commitment to a specific group plan for managing the resource (the social-structural component of the intervention), against appropriate control conditions. In this experiment, groups of four subjects harvested points from a computer-controlled, regenerating resource pool in order to accrue personal points. These points, at the end of the experiment, were converted into lottery tickets that gave subjects an opportunity for winning cash or gift certificates to a record store. An incentive system intended to reward low rates of individual and group consumption was created by providing bonus points to all group members after every set of 10 trials in which they maintained the common resource at or above a criterion level (Mixed Incentive). This incentive structure was tested against one, similar to those found in most trap-like situations, which encouraged high rates of resource usage by rewarding every consummatory response on a continuous reinforcement schedule (Short-Term Incentive). Commitment was manipulated after an initial experience with the analogue. Subjects were given an action plan which was portrayed as the result of their input regarding harvesting strategies. In the High Commitment conditions a public indication of agreement to the plan was required

of all subjects in each group. In the Low Commitment conditions the plan was explained but no overt sign of assent to the action strategy was required.

It was predicted that: (1) groups exposed to the Mixed Incentive system would maintain their resource pool substantially longer than those exposed to the Short-Term Incentive system and (2) groups in High Commitment interventions would sustain the pool-of-points significantly longer than those who were exposed to Low Commitment manipulations and they, in turn, would perform better than those in No-intervention control groups.

METHOD: EXPERIMENT 1

Design overview

Randomly assigned, four-person groups participated in a simulated 'commons trap'. Two levels of Incentive systems (Short-Term and Mixed) were crossed with three levels of Intervention (High Commitment, Low Commitment, and a no-intervention control) in a between-subjects design. Each subject was allowed to harvest from 0 to 4 points on each trial from a pool which was then replenished by multiplying the remaining points by a constant of 1.0638297. This replenishment rate was designed to return the pool to a full 100 points, if it contained 94 or more points at the end of a trial. In addition, subjects in all conditions were provided with information about their own and each of the other persons' point totals, along with feedback concerning the exact trial-by-trial pool level. Finally, total trials to resource depletion, total points accumulated by each group, and total points replenished to the resource pool served as the dependent variables.

Participants

One hundred and twelve male subjects, from 18 to 22 years of age, participated in partial fulfilment of requirements for an introductory psychology course.

Apparatus

The apparatus consisted of the on-line 'Points-from-Pools' simulation consisting of a PDP 11/70 terminal and CPU, a printer, four CRTs, and custom software. This apparatus creates a computer analogue for social traps in which subjects draw points from a replenishing pool by typing in the number of points desired on each trial on the CRT keyboard. Pool level, points earned, and other forms of feedback concerning the performance of players can be manipulated and displayed on the CRTs.

Procedures

The incentive manipulation. In the Short-Term Incentive condition, subjects were told that there were 100 points in their common pool and each could choose to take from zero to four points, per trial, from the pool. In addition, subjects were advised they would each receive one lottery ticket for every *five* points they personally earned, the total of which they would collect at the end of the session. Each ticket would then be entered in a draw, along with the tickets earned by all subjects who participated in the experiment during that semester. The winner would receive $10 in cash or a gift certificate for merchandise at an area record store. The experimenter

stated that the objective was to obtain as many personal points as possible which was, in fact, the optimum strategy for each individual. Finally, subjects were told that they would be allowed some practice trials, in which they would receive no lottery tickets, in order to become familiar with the task. They were then seated at terminals in isolated cubicles, hidden from each others' view, and instructed not to communicate among themselves during the remainder of the experiment. The number of practice trials was not fixed; rather subjects were allowed to harvest points until their common pool was exhausted (this generally took from eight to 13 trials).

The instructions for the Mixed Incentive condition were essentially the same. The only difference was that subjects were told they would each receive one lottery ticket for each *10* personal points they each earned and a bonus of four lottery tickets per person after every 10 trials during which the group had maintained the pool at or above 90 points.

Once the subjects finished the practice trials, the experimenter selected, from a coded, randomized list, the intervention condition to which the group would exposed.

The commitment manipulation. In the Control conditions, the participants were merely told that the practice session was over, and to await silently the beginning of the experimental phase of the study. When the practice session ended for those in the High Commitment condition, subjects were each given a questionnaire which asked for their perceptions of the task, their evaluation of the group's performance in the practice trials, and for their recommendations with respect to possible group response strategies. After the participants had finished the questionnaire, the experimenter collected them and pretended to perform a brief data analysis of the responses. Upon completion of the 'analysis', the experimenter surreptitiously exchanged the notes he was writing for a standardized, handwritten intervention script.

The subjects were then summoned to a 'conference table' and the experimenter summarized for them the data from the scripted analyses. He stated that their responses to the questionnaire indicated: (1) they thought group members were taking too many personal points from the common pool on each trial; (2) that no more than six points should be harvested by the group on any given trial; and finally (3) that a good way to do that was to have two subjects each take two points on a given trial, while the remaining two subjects take one point each.

The experimenter then proposed the following alternating group harvesting strategy, which he said fulfilled the general recommendations which had emerged from 'the subjects' answers' to the questionnaire. Participants were told that a reasonable way to accommodate these recommendations was to have subjects A and B each take two points on every even numbered trial, while subjects C and D each took one point—then on every odd-numbered trial, subjects C and D would each select two points and A and B would each harvest one point. Group members were told that, by following such a strategy, the pool might last longer and that each participant could accrue a large number of personal points.

The strategy provided to the subjects was derived from the recommendations made by 12 groups in a pilot test of the analogue and procedures. The alternating aspect of the strategy was included by the investigators to create an action plan that required continuous attention and thoughtful processing on the part of the subjects in order to implement it successfully. Such a strategy creates a laboratory analogy to many

real-world commons problems in which the implementation of a solution requires a high level of monitoring and sustained effort.

Following these recommendations the investigator directed participants in the High Commitment condition to consider whether or not they would be willing to act according to the proposed strategy. They were advised that they were free to adopt some other strategy or no strategy at all. Finally, they were asked to indicate, by a show of hands, whether or not they intended to behave in accord with the action plan. After a unanimous show of hands, the experimenter directed the subjects to return to their terminals.[1]

The procedure for the Low Commitment intervention differed only in that the investigator merely directed the subjects to consider whether or not they would be willing to act in accord with the strategy. He did not ask for a public sign of agreement to the action plan.

After the intervention the resource pool was restored to 100 points and the task began anew for the subjects. The experiment terminated once the subjects had either run the pool down to zero points, or 100 trials had elapsed—subjects were not informed of the 100 trial limit, however. Upon termination, the participants were given a debriefing survey to complete. The questions on this instrument served as manipulation checks for the subjects' understanding of the incentive structure and, in the High and Low Commitment conditions, their perceptions of commitment to the action plan. It also probed for any suspicions the procedures may have engendered. Once these questionnaires had been completed and collected, the subjects were given a written explanation of the study and then a thorough verbal debriefing. Finally, they were sworn to secrecy and paid in lottery tickets according to the schedule described in the incentive instructions.

Dependent variables

The three dependent variables in this investigation were recorded during the trials that took place after the experimenter's intervention. The total number of trials until the resource pool was exhausted, the total number of points earned, and the total number of points replenished to the common pool were recorded for each group (hereafter these variables will be referred to as 'total trials', 'total points', and 'total points replenished'). These related variables all indicated the extent to which groups successfully managed their shared resources.

RESULTS

Overview

Suspicion of the procedures, uncovered during written and verbal debriefing, resulted in dropping three groups from the analyses. Those groups had been assigned to the Mixed Incentive–High Commitment, Short Term Incentive–High Commitment, and Short Term Incentive–Low Commitment conditions. The following results are based on data from the remaining 25 groups.

[1] A unanimous show of hands was obtained in all but one group. In this group a subject openly expressed to the others and the experimenter his suspicion of the study, and his unwillingness to 'cooperate'. The group completed the experimental procedure, but was one of the three groups dropped from the analyses due to suspicion of the procedures.

A multivariate analysis of variance (MANOVA) would ordinarily be conducted on data characterized by multiple dependent measures. However, in this study the outcome of the three dependent variables (total points replenished, total trials and total points) precluded such an analysis. The two main impediments to the use of the MANOVA technique were a high degree of multicollinearity among the dependent variables and violation of the homogeneity of variance assumption. The within- and across-cells correlations for the three outcome variables were no less than $r = 0.992$. Such high intercorrelations indicated an extreme case of multicollinearity, which would lead to biased MANOVA results. Ceiling effects were also detected, yielding variances equal to zero within two cells of the design. Thus, the assumption of homogeneity of variance among cells could not be maintained. As a consequence, instead of the traditional multivariate tests, 2 × 3 (Incentive system × Commitment strategy) univariate analyses were performed on group responses.

These analyses yielded virtually identical results for each of the three dependent variables, as might be expected given their extremely high intercorrelations. It has been argued that total trials, total points and total points replenished reflect subtly different behavioural processes in resource consumption (Linder, 1982; Allison and Messick, 1985). In our experiments all three measures responded in a similar way to the independent variables we manipulated, rendering such arguments moot. To minimize repetition, results of tests of significance have been reported only for total trials. The two instances in which there is a slight discrepancy between total trials results and those for the other two dependent measures are noted in the report of results for Experiment 2. Means and standard deviations for all three dependent variables are reported in Tables 1 and 2.

An alternative dependent variable, final pool size, has also been suggested (Allison and Messick, 1985). However, it is an inappropriate and uninformative measure for these experiments. The majority of the groups in both studies completely depleted the pool, yielding a final pool size of zero. The number of trials until depletion (total trials), therefore, is a more informative index of resource management.

Interactions and main effects

No significant univariate interactions obtained ($F(2,19) = 0.812$, n.s.); however, analyses for type of incentive system yielded significant effects ($F(1,19) = 8.99$, $p = 0.007$). As indicated by the means and standard deviations displayed in Table 1, the data clearly support the superiority of the Mixed Incentive system over the Short-Term Incentive system in eliciting resource conservation.

In addition, significant univariate effects were found for the commitment variable ($F(2,19) = 23.86$, $p < 0.001$). Therefore, non-orthogonal planned contrasts were employed to test the ordering hypothesis for this variable. Expected differences between the High and Low Commitment conditions did not materialize ($t(22) = 0.332$, n.s.). However, the comparison between the Low Commitment and Control groups did reveal the expected differences ($t(22) = 4.710$, $p < 0.001$).

DISCUSSION

The incentive systems

As predicted, the results of Experiment 1 showed that while the Short-Term Incentive

Table 1. Means and standard deviations for dependent variables in Experiment 1

	Short-term incentive		Mixed incentive	
Dependent variables	*M*	SD	*M*	SD
High commitment				
Trials	71.75	28.39	100.00	0.00
Points	441.25	147.66	552.50	23.19
Points replenished	361.50	172.97	544.75	21.09
	($n = 4$)		($n = 4$)	
Low commitment				
Trials	63.25	16.86	100.00	0.00
Points	385.75	89.46	574.50	10.75
Points replenished	290.75	87.23	569.75	12.53
	($n = 4$)		($n = 4$)	
Control				
Trials	10.25	3.30	33.40	37.37
Points	127.50	13.89	233.20	186.81
Points replenished	31.75	12.61	156.60	229.14
	($n = 4$)		($n = 5$)	

system drew groups into social traps, the Mixed Incentive system was effective in helping subjects avoid the traps. This hybrid incentive system was therefore successful in helping groups maintain their resource pools at high levels, and it also allowed subjects to accrue greater profits than their counterparts working within a short-term framework. A full discussion of these findings will be presented in the general discussion at the end of this article.

The intervention strategies

Results also supported the hypothesis that commitment induced through second-party interventions produced effective pool management. The analyses provided clear evidence of the superiority of second-party interventions over no-intervention controls. Though it may be argued that knowledge of the optimal solution is a sufficient condition for more effective harvesting behaviours in both High and Low Commitment groups, other researchers have found such information has produced little impact on harvesting behaviours (Edney and Harper, 1978). In addition, an experiment by Allison and Messick (1985) has found that individual experience at the task did improve subsequent group performance compared to inexperienced groups. However, those who obtained task experience in a group setting did not perform substantially better than inexperienced control groups. Therefore, it is more likely that aspects of the commitment manipulations—other than their group experience or the mere knowledge provided by the experimenter in these interventions—accounts for the substantial differences between the Control and Commitment groups.

Though sizeable differences did obtain between the intervention and control groups, the data did not yield any significant differences between the two intervention strategies (High versus Low Commitment groups) in terms of their behavioural effects on group resource harvesting. In other words, public commitment to a 'group-derived' action plan appeared not to be substantially better than merely hearing that plan

in the presence of others, with respect to the consummatory behaviours each strategy elicited.

Level of participation: the neglected issue

Upon reviewing Experiment 1, it becomes evident that while the High and Low Commitment interventions differed in the degree of overt commitment elicited, subjects in both groups may have had a strong sense of having shared in the development of the strategy offered by the experimenter. Both groups participated in filling out the questionnaire and both groups listened to the same exposition by the experimenter. In all cases the experimenter was observed to examine the subjects' questionnaires quite closely before telling the group that their responses were summarized in the plan he would outline. Early research (Coch and French, 1948) in the Lewinian tradition suggests that a sense of participation in the development of a plan for change is accompanied by greater acceptance of that plan. The only difference between the conditions was that one group publicly committed to the action plan while the other did not. The absence of significant mean differences between the treatment groups, then, may be due to the fact that they were both engaged at the same level of participation in the action plan development. Hence, to better understand the effect of different levels of participation on individuals' behavioural commitment to resource conservation strategies, it was necessary in Experiment 2 to allow groups to participate in filling out the questionnaires; but in some groups the results were attended to by the experimenter, while in others the group responses were conspicuously ignored in favour of a solution proposed unilaterally by the experimenter.

Research aimed at separating the effects due to level of participation from the effects of commitment is important for understanding the mechanisms by which interventions work in commons traps. While participation has been explored in the group decision-making literature, it appears that no social traps research exists bearing on this issue. In addition, the pattern of results obtained in Experiment 1 indicates that a high level of participation may be a sufficient condition for adherence to a plan for resource management. Furthermore, when the sense of participation is high, attempts to manipulate commitment may be ineffective. Either a high level of commitment is a concomitant of high participation or the high levels of adherence observed in the first study precluded further gains based on enhanced commitment. However, if a high level of participation is a sufficient condition for adherence, it remains to be determined if participation is also a necessary condition, and what role commitment can play when participation is reduced or eliminated. Thus, a factorial design, crossing these two variables, is suggested.

Feedback and surveillance

Adherence to the agreed action plan also may have been maintained in Experiment 1 by the nature of the feedback each group member received. Each member was informed after every trial of the new resource level and the number of points taken by each other member. Thus, it would be readily apparent if any subject deviated from the action plan. Effectively, every subject was under the surveillance of the entire group, and defection would have been a very public act. Under such circumstances exploitation may be inhibited. Moreover, the relationship between participation and commitment, even their separate effects, may be quite different when

exploitation is disinhibited. Thus, if feedback about the behaviour of each individual is suppressed, while feedback about pool level and group behaviour remains available, then defection by individuals will be anonymous and perhaps more likely (McClintock and Van Avermaet, 1982; Messick *et al.*, 1983). Under these conditions a high level of participation and a high level of public commitment may be required to maintain adherence to the action plan offered by the experimenter. The form of the relationship between participation and commitment in the absence of individual surveillance is difficult to specify *a priori*. However, it is likely to be changed, resulting in a statistical interaction among the three independent variables.

Summary and research questions

Experiment 2, then, was designed to explore further the role of commitment in supporting cooperative behaviour. However, the procedure was redesigned so that the subjects' sense of participation in the development of the solution could be manipulated independently of the commitment variable. In addition, two levels of surveillance were created. This allowed an exploration of the effects of participation and commitment when subjects could be sure that they could defect anonymously, as well as when defection was a public event.

In Experiment 2 all subjects were exposed to a Short-Term Incentive structure. However, the feedback given to subjects on their terminals was varied between groups, such that some were exposed only to information about their individual performance and the resource pool level (Individual Feedback), while other groups received this information along with data on all other group members' performance (Group Feedback). Individuals in the Group Feedback conditions were expected to adhere to the action plan more than those in the Individual Feedback groups, due to the differences in response visibility.

The sense of individual participation in developing the action strategy was manipulated by conspicuously ignoring the survey responses of some groups in favour of providing them with a strategy developed by the experimenter (Low Participation). In other groups the experimenter appeared to attend to the group's survey input and provided them with a (the same) strategy, which was purportedly an aggregate of their individual contributions (High Participation). Expectations were that those who felt a greater level of participation would maintain behaviour more in line with the action plan, compared to those in Low Participation conditions.

Finally, the level of commitment was manipulated as in Experiment 1. Again, it was predicted that the High Commitment manipulation would lead group members to comply more fully with the action plan than those in Low Commitment conditions.

In summary, the research questions to be addressed in Experiment 2 are: (1) Do high levels of Participation and Commitment lead to effective resource management? (2) Are the effects of Participation additive (main effects) or multiplicative (an interaction)? (3) Does the form of Feedback (surveillance) have a main effect? (4) Finally, does the way in which Participation and Commitment affect cooperation change when the form of Feedback is changed (a three-way interaction)?

METHOD: EXPERIMENT 2

Design overview

The three independent variables were each manipulated at two levels in this between-

subjects design. In addition, a no-intervention control group was created at each level of the Feedback variable. The resulting design was a 10 cell, 2 × 2 × 2 + 2 experiment, in which two levels each of Commitment, Participation and Feedback were fully crossed, and one no-intervention control group was nested within each level of Feedback. Total trials, total points and total points replenished again served as dependent measures.

As in Experiment 1, each subject was allowed to harvest from zero to four points on each trial, from a pool which replenished after each trial at the rate of 1.0638297 of the remaining resource pool points. Also, as in Experiment 1, subjects were seated at terminals in isolated cubicles, given practice trials, and instructed not to communicate with each other during the experiment.

Participants

One hundred and eighty male subjects, ranging in age from 18 to 22 years, were utilized from the Introduction to Psychology subject population. The subjects were run in groups of four and received 1 hour of experimental credit towards a course requirement, along with earned lottery tickets, for their participation in this study.

Apparatus

The same apparatus and materials used in Experiment 1 were used in Experiment 2.

Procedures

The feedback manipulation. Subjects in the Individual Feedback condition were told in the orientation that they would receive only information about the number of points that they, as individuals, had accrued. Subjects in the Group Feedback condition, on the other hand, were told they would be provided with information about both their own and each of the other persons' point totals. In addition, both groups were exposed to feedback concerning the exact trial-by-trial pool level and the total number of points taken on each trial.

The commitment manipulations. The procedures for the Control conditions and the High and Low Commitment conditions were the same as in Experiment 1.

The participation manipulation. The description for the Commitment manipulations in Experiment 1 represents the High Participation condition in this study. In the Low Participation condition the experimenter merely told the subjects to leave the questionnaires at their tables, and then asked them to the conference table. After gathering the respondents at the conference table, the investigator gave the same exposition as in the first experiment, with the exception that he stated that the proposed harvesting strategy was what he believed was the optimal response pattern (as opposed to what had emerged from the group as the optimal response pattern).

After the intervention phase of the experiment the task began anew for the subjects, with the resource pool restored to 100 points. The experiment terminated once the subjects had either depleted the pool or 100 trials had elapsed.

When the experimental phase ended, the participants filled out questionnaires

and went through the same debriefing procedures as their counterparts did in Experiment 1.

Dependent variables. The same three dependent variables (total points, total points replenished and total trials) used in Experiment 1 were used in this investigation. They were recorded following the intervention phase of the experiment.

RESULTS

Overview

A multivariate analysis of variance (MANOVA) was found again to be inappropriate to examine the results of this study. As in Experiment 1, the outcome of the primary dependent variables (total trials, total points and total points replenished) precluded such an analysis, because the average within-cells correlations for the three outcome variables were no less than $r = 0.945$. The homogeneity of variance assumption was also tested, but found not to be violated ($C[10,4 = 0.3289]$, n.s.; Winer, 1971). As a consequence, $2 \times 2 \times 2 + 2$ (Feedback × Commitment × Participation + trailing Controls) univariate analyses were performed on these dependent measures instead of the multivariate tests. Means and standard deviations, by condition, for the three dependent variables are displayed in Table 2.

Simple interaction effects, simple main effects, and pairwise comparisons will be presented in the text where it seems necessary to explicate further the interactions and main effects. In addition, due to the high degree of intercorrelation among dependent variables, only the tests of significance for total trials will be presented. In the two instances where the tests of significance yield slightly differing results, the tests for all three dependent measures will be reported.

Main effects

All three independent variables did produce significant univariate results (Feedback, $F(1,35) = 7.27$, $p < .05$; Commitment, $F(1,35) + 22.81$, $p < 0.001$; and Participation, $F(1,35) = 5.62$, $p < 0.05$; see Table 3), such that the more Feedback, Commitment and Participation to which each group was exposed, within the context of an intervention, the better they managed their common pool resources.

Feedback × Participation interaction

No combined effect of these two variables was evident for the outcome measures ($F(1,35) = 0.132$, $p = 0.719$).

Feedback × Commitment interaction

A significant Feedback × Commitment interaction was obtained ($F(1,35) = 18.79$, $p = 0.001$). The combination of these two factors produced a magnitude interaction, in which the superiority of High Commitment was diminished somewhat under conditions of Group Feedback. Groups exposed to Low Commitment, on the other hand, evidenced an increase in their performance within the context of Group Feedback.

An examination of the simple interaction effects reveals a significant and unexpected crossover interaction for Feedback × Commitment within Low Participation

Table 2. Means and standard deviations for dependent variables in Experiment 2

	Group Feedback				Individual Feedback			
	High Commitment		Low Commitment		High Commitment		Low Commitment	
Dependent variables	*M*	SD	*M*	SD	*M*	*SD*	*M*	SD
High Participation								
Trials	96.25	7.50	55.80	21.80	95.00	10.00	31.20	16.98
Points	513.50	39.20	360.40	113.06	548.75	46.96	217.60	71.31
Points replenished	467.40	76.89	262.55	111.04	521.81	93.75	120.63	70.70
	($n = 4$)		($n = 5$)		($n = 4$)		($n = 5$)	
Low Participation								
Trials	43.50	24.66	77.40	23.40	64.25	15.11	29.75	10.14
Points	294.75	110.29	448.60	109.40	397.00	85.15	215.50	49.03
Points replenished	199.85	111.31	385.46	149.15	303.07	83.89	119.79	47.37
	($n = 4$)		($n = 5$)		($n = 4$)		($n = 4$)	

Dependent variable	*M*	SD
Control		
Trials	13.20	5.45
Points	137.40	22.39
Points replenished	44.66	18.74
	($n = 4$)	

Dependent variable	*M*	SD
Control		
Trials	12.00	4.53
Points	136.00	16.67
Points replenished	38.31	17.66
	($n = 5$)	

Table 3. Univariate results for total trials. Experiment 2

Source	d.f.	F	p
Feedback	1,35	7.27	<0.05
Commitment	1,35	22.81	<0.001
Participation	1,35	5.62	<0.05
Feedback × Commitment	1,35	18.79	<0.001
Feedback × Participation	1,35	0.132	n.s.
Commitment × Participation	1,35	23.82	<0.001
Feedback × Commitment × Part	1,35	4.39	<0.05
Group Feedback Controls vs. Individual Feedback Controls	1,35	0.013	n.s.
Treatment vs. Control groups	1,35	73.13	<0.001

($F(1,35) = 16.34$, $p < 0.001$). In the context of Low Participation and Low Commitment, Group Feedback elicited better performance than did Individual Feedback ($M = 77.4$ and 29.75, respectively). Unexpectedly, under conditions of Low Participation and High Commitment, Group Feedback was less effective than Individual Feedback ($M = 43.5$ and 64.25, respectively). Therefore, the Feedback variable produced an unpredicted and curious effect in the context of Low Participation and High Commitment.

Feedback × Commitment within High Participation, however, behaved as expected. A significant simple magnitude interaction was found for two of the three outcome measures (total points, $F(1,35) = 5.59$, $p = 0.025$; total points replenished, $F(1,35) = 4.82$, $p = 0.037$; total trials, $F(1,35) = 2.45$, $p = 0.129$). When Commitment was high, the form of Feedback did not affect performance. However, within the context of Low Commitment, Group Feedback elicited better performance than did Individual Feedback.

Commitment × Participation interaction

Significant univariate findings were revealed for this combination of independent variables ($F(1,35) = 23.82$, $p = 0.001$). The effect was in the form of a magnitude interaction, with the High Commitment/High Participation condition being most effective. The Low Commitment condition demonstrated little differential effectiveness between the High and Low Participation conditions.

The simple interaction evidenced the same form as above for Commitment × Participation within Individual Feedback ($F(1,35) = 3.64$, $p = 0.067$). Hence, under conditions of Individual Feedback, the combination of High Commitment/High Participation yielded the most effective harvesting strategies.

Commitment × Participation within the context of Group Feedback yielded a significant crossover interaction ($F(1,35) = 17.87$, $p < 0.001$). Better performance occurred among Low Commitment ($M = 77.4$), rather than High Commitment ($M = 43.5$) groups, when they engaged in a Low Participation intervention. High Commitment groups ($M = 96.25$), however, dramatically increased their performance over Low Commitment groups ($M = 55.8$) when exposed to a High Participation intervention.

Though there were disparities between the performance of Commitment and Parti-

cipation within differing levels of Feedback, some consistency was evident. Independent of the type of Feedback provided participants, superior performance always results when High Commitment was combined with High Participation. Also, it appeared that low levels of Commitment generally reduced the effectiveness of Participation in getting individuals to comply with a resource management strategy.

Feedback × Commitment × Participation interaction
Univariate analyses of the three dependent variables found only total trials to produce a significant three-way interaction (total trials, $F(1,35) = 4.39$, $p = 0.043$; total points, $F(1,35) = 2.35$, $p = 0.134$; total points replenished, $F(1,35) = 2.09$, $p = 0.158$).

Group Feedback Controls vs. Individual Feedback Controls
No significant differences were found between the two control groups ($F(1,35) = 0.013$, $p > 0.90$). These groups experienced no intervention, rather they only received full Group Feedback or Individual Feedback and, as evidenced by the planned contrast, the feedback manipulation had virtually no effect in the absence of an intervention.

Treatment vs. Control groups
As predicted, significant differences resulted when treatment groups were pooled and compared against the combined control groups ($F(1,35) = 73.13$, $p < 0.001$). Thus the intervention embodied in the various treatment combinations produced a substantial effect on resource management. The manner in which these treatment variables combined to produce such major effects was of primary interest in this experiment.

DISCUSSION

Each of the three independent variables in this study had a significant impact on the behaviour of groups in the social trap analogue. While there were some interactions between independent variables, to which we will soon turn our attention, the main effects can be discussed prior to the introduction of the finer nuances embodied in the interactions.

The effects of Group versus Individual Feedback indicated that identifiability alone is not sufficient to inhibit resource exploitation. In the no-intervention control groups the resource was depleted just as quickly in the Group Feedback condition as in the Individual Feedback condition. However, after an intervention, Group Feedback, in which each person's use of the resource was identifiable, led to better management of the resource than Individual Feedback, in which it was possible to overharvest in anonymity. This pattern of results suggests that surveillance is ineffective in a social vacuum. Without some sense of group identity, and/or some information about expected behaviour, visibility does not deter exploitation (Kerr, 1990).

As suspected from the results of Experiment 1, participation in the development of the prescribed behavioural pattern leads to better adherence and better outcomes for the group, whether or not a public commitment to the plan was required. Because there was possibly a strong sense of participation in both the High and Low Commitment conditions of Experiment 1, the failure to find a strong effect for Commitment can be understood as due to our failure to either control or manipulate subjects'

sense of participation. The results of both experiments, then, confirm the importance of a sense of participation in the development of plans for behaviour change (Coch and French, 1948). Adherence is more likely when each individual has a sense of having had a say in the planning. In addition, Miller and Monge (1986) have provided a meta-analytic review of research on the effects of participatory decision-making, finding that participation has a moderate positive influence on productivity, motivation, and job satisfaction. Earlier research by Coch and French (1948) has also shown that acceptance of change is enhanced as much by a system of representation as by personal participation. Thus, it may be possible to gain adherence to a restrained pattern of resource consumption in large collectives by developing an organizational structure that allows representation rather than the more cumbersome full personal participation. Field studies, or a rather elaborate manipulative experiment, will be required to test this promising possibility.

The present experiment provided strong confirmation of the efficacy of commitment in eliciting adherence to a plan for restrained resource consumption. The procedure by which commitment was manipulated was identical in the two experiments reported in this paper, but there was an important change in the information available after each trial. In Experiment 2, all subjects were informed of the total points taken on the last trial by the entire group. This information may have allowed subjects to monitor the group's behaviour more accurately. Subjects in the High Commitment conditions could then react to overuse by reducing their own demands, while subjects in the Low Commitment conditions could easily see when the behavioural plan was being violated, and follow suit. These results provide empirical support for the argument developed by Kerr (1990) that a 'commitment norm' may function in social dilemmas so that people feel a normative pressure to keep their promises concerning resource consumption.

The interactions between the independent variables can be best understood by focusing on the Commitment × Participation interaction within the two levels of Feedback (see Table 2). The pattern of means within the Individual Feedback condition suggests that High Commitment is of primary importance when the resource can be exploited anonymously. The Low Commitment condition led to low levels of adherence regardless of the level of Participation, while High Commitment led to much greater adherence, even when Participation was low. The combination of High Commitment and High Participation elicited the highest levels of adherence in both Individual and Group Feedback conditions. The implication is that if both High Commitment and a sense of participation can be established, close surveillance may not be necessary to ensure restrained use of the resource. However, if surveillance is impossible or impractical it may be critically important to obtain clear commitments to the prescribed use pattern.

The results under conditions of Group Feedback are somewhat puzzling because the interaction of Commitment and Participation takes a different and unexpected form, due to the high level of adherence in the Low Commitment–Low Participation condition. It is possible that the independent variable manipulations that produce this treatment combined to create a very different social-psychological structure within which the subject had to function. The sequence of events in which the subjects fail completely in a trial game on the analogue, fill out a questionnaire which is then pointedly ignored, are told how to behave in order to succeed in the analogue, and are ordered back to their terminals aware that every response will be known

to all participants may have called forth an 'obedience' schema, or put subjects in an 'agenetic' state (Milgram, 1965, 1974). Told exactly what to do and under the surveillance of their fellow-participants, subjects may have simply followed instructions.

This is admittedly a *post hoc* explanation, and both replication and explication will be required before such a procedure could be recommended as a way to resolve a social dilemma. Meanwhile, it is clear, having noted this one exception, that behaviour in this social trap analogue can be strongly influenced by commitment and participation manipulations, in a manner quite congruent with expectations based on a social-psychological analysis.

GENERAL DISCUSSION

Garrett Hardin warned us in his seminal paper, 'Freedom in the commons brings ruin to all' (Hardin, 1968, p. 1244). In this work, and the volume of papers and books he has written since, his message is the same: human behaviour must be constrained, because technology and science will not deliver us from the traps we have set for ourselves. He did not, however, advocate coercion from above; rather, he championed 'mutual coercion, mutually agreed upon'. Consequently, the independent variables in Experiments 1 and 2 were chosen because of their relevance as human, not technological, remedies, and because they resemble solutions which are concomitants of most successful, cohesive group actions oriented towards the common, as opposed to egocentric, good. Therefore, the focus of this discussion will be on understanding why these variables functioned as they did and to what practical situations they apply.

Incentive systems

Our behaviours, as members of society, are continually modified and shaped by the social sanctions we have come to adopt. Behaviours which conform to accepted norms are rewarded, while those which do not are punished. These sanctions function as a form of mutual coercion and serve to keep our behaviours within socially acceptable limits most of the time.

If we view the incentive structures in Experiment 1 as a set of criteria by which individual and group behaviour was regulated, then it is evident that the different reward systems sanctioned different normative structures. The norm for groups exposed to the Mixed Incentive system (MI) rewarded individuals for behaving in a cooperative manner, while those exposed to the Short-Term Incentive structure (STI) were rewarded for pursuing individual aims. More specifically, by having a criterion-based bonus system, the MI explicitly established an inhibiting factor to govern unrestrained individual harvesting. Moreover, it rewarded conservative harvesting, and thereby made evident the interrelationship between individual and group success. To gain as many personal points as possible, subjects had to maintain the common resource for all. The norm for those in the STI, on the other hand, was driven by an incentive aimed only towards accumulating as many personal points as possible. Thus, the actual connection between individual and group success was obscured and individuals pursued socially competitive behaviours focused on unconstrained individual gain.

The STI, it may be argued, is a reasonable representation of the incentive structure by which many of us are reinforced in utilizing the resources of our nation. Take, for example, the pay structure of chief executive officers (CEOs) and managers of American organizations. They receive bonuses and other options based on current quarterly and annual profits (Thurow, 1980, 1981). Therefore they are being reinforced specifically for the short-term accumulation of wealth, while the value of long-term organizational viability is discounted. With such reinforcement structures it is easy to understand why a concomitant of new management and organizational takeovers is layoffs and firings; the closing of departments; decreased down-time for the maintenance of machinery; and increased restrictions on benefits, sick leave and vacations. Such actions increase short-term 'productivity' and yield more substantial bonuses for management. However, businesses then become trapped in the vicious cycle of working for continuous short-term profits with exponentially decreasing effectiveness (Thurow, 1980; Maital, 1982). The long-term integrity of the organizational infrastructure is thereby compromised, and it becomes prey for subsequent leveraged buy-outs and other takeover attempts. This in turn fuels disaster for the financial institutions, such as Savings and Loans, which underwrite these deals. In the long run we all pay for the massive debts that result from the decisions of individuals operating within such incentive systems. And it is in this way that American productivity (as measured by gross national product, national trade figures, and national debt, etc.) and our general societal welfare is diminished.

The MI system is a potential solution to such problems, because instead of discounting or disregarding the future (as in the STI), the MI places a premium on responsibility to it. It still reinforces short-term horizons at a discount, because to ignore the present entirely would be to lose in the long run (Pastin, 1986). This MI system is therefore consistent with Lester Thurow's (1981) admonition to pay CEOs and managers based on long-range business profits, rather than short-term. He states that:

> If CEO's ... were paid based on the long-run profits of the firms they manage, the internal structure of the firm would soon change to lengthen the time horizons of both middle management and the financial markets (Thurow, 1981, p. 78).

The application of such contingencies is quite feasible in terms of pay and bonus structures. Unfortunately, however, many social traps are embedded in political and economic structures that prevent manipulation of the reward structure, so that application of these findings to other kinds of naturally occurring dilemmas may often be difficult or impossible. For instance, how exactly do you construct an effective MI system to promote car pooling, disuse of products containing chlorofluorocarbons, or saving endangered species? Certainly, these problems are not readily amenable to mere manipulation of an incentive system. They take solutions which encompass intrinsic as well as extrinsic regulation.

Let us take, for example, the promotion of car pooling in cities such as Los Angeles and Phoenix. As mentioned earlier, both cities are beset by tremendous air pollution problems, due mainly to the citizens' dependence upon and frequent use of their automobiles. Attempts have been made to resolve this problem by creating car pooling lanes for individuals with at least two occupants per car, promoting 'ride one-in-five' campaigns, or expanding public transit. All of this is to no avail. These remedies

have failed because, at least in part, they rely on the belief that individuals will readily sacrifice the personal comfort and convenience of their automobiles in favour of better-quality air, if they are merely made aware of the consequences of their actions. The bulk on research on resolving social dilemmas shows these interventions to be ineffective.

In general, proselytizing, moralizing and educating the population may be useful in consciousness-raising. Such techniques, however, are not often useful in translating the new level of consciousness into action. These approaches fail because they do not instantiate a sense of personal responsibility for the problem or its solution. In order to engender this feeling, and to generate consonant norms and behaviours, the citizenry need first to be involved in and committed to the process.

Participation and commitment

Both experiments clearly demonstrated the importance of having individuals reflect on their imprudent resource-harvesting behaviours, and of *involving* them in the process of considering alternative behaviour patterns. These activities appear to have primed the individuals to evaluate their personal and group responsibility for the dilemma, which subsequently made them more susceptible to the recommendations advanced by the experimenter. Translating this to the air-pollution problem above, it suggests that for an intervention to be at least minimally effective it must encourage *and* actually elicit active and effortful personal consideration of the community's dilemma, before a solution is advanced.

We can apply this knowledge to better comprehend why citizens of Phoenix, Arizona, for example, recently voted down an attempt by Phoenix city government to implement a valley-wide public transportation system (known as Val Trans) that was ostensibly in the citizens' best interest. The particulars of the system, which were announced shortly before the election, included a rapid-transit elevated railway, increased bus routes, more buses, etc. It was touted by officials and transportation experts as a necessary solution to effectively cut down air pollution and ameliorate increasing traffic congestion in the metropolitan area. The results from Experiment 2 give us some insight into why the apparently reasonable city plan failed to gain voter support. Citizens had no input in the development of the plan and there was no community commitment to the specific points of the proposition.

We would have advised city officials that, rather than designing a transportation plan in a social vacuum, they could have more effectively spent their time and resources by eliciting the opinions of citizens who would have to live with the consequences of the plan. More specifically, officials could have approached this programme by involving citizens in identifying key problem areas, providing potential solutions for ameliorating the pollution and congestion problems, and then using this information to create a strategy to which a large number of individuals felt that had contributed. In this way a Val Trans project may have won voter approval.

To go further and get maximal effectiveness from an intervention, our experiments show individuals must feel a sense of commitment to the conservation strategy. Furthermore, those commitments should be active, effortful, public, and perceived as internally derived (Sensenig and Cialdini, 1982). Such conditions existed in our High Commitment–High Participation cells. In those groups, individuals were asked to consider the nature of their predicament and possible solutions. In addition they were led to believe that the strategy proposed by the experimenter was one based

on their aggregated responses to a survey. Finally, they were asked to indicate publicly their intentions to follow the action plan. The commitment that arose as a consequence of these procedures led groups, even in the absence of surveillance, to adhere rigorously to the strategy.

With the advent of television polling and other video polling systems, it is evident that the necessary technological structures are available to implement large-scale—even society-wide—interventions of the kind tested in Experiment 2. Using these recently developed technologies, individuals from disparate locations can call in their responses to questions posed on the air, through audio and video link-ups. These responses can then be used as the basis for formulating a mutually agreeable group action plan, upon which a citizenry could vote. The application of current technology in this manner could be used as a vehicle to create the feeling of community to which members would feel a greater sense of involvement and responsibility. Consequently, Garrett Hardin's (1968) notion of 'mutual coercion, mutually agreed on' would become a more realistic solution to large-scale dilemmas.

Interventions such as the ones above, then, may be applied to and tested in natural settings to ascertain the *in vivo* strength of these variables. For example, information about a county's air-pollution problem could be related to the citizens over television broadcasts. Afterwards, data could be collected from the community, concerning their thoughts about issues of appropriate resource-management strategies. The results of those data could, in turn, be fed back to group members over television, and a community video poll could be taken regarding the issue(s) at hand. Such strategies may be useful in making and implementing critical decisions in a timely fashion, with a maximum impact on citizens' feelings of participation in and commitment to an action plan. In turn, it should encourage more compliance to even rather inconvenient resource-conservation strategies and, therefore, ultimately encourage less free-riding.

These experiments indicate that behaviour in a social trap can be modified dramatically by behavioural and social-structural interventions that focus on the effective use of an optimizing strategy. In combination with developing telecommunication technology, these interventions may offer a possible procedure for eliciting adherence to the optimizing solution strategies for some of our most intractable social dilemmas.

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