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# ON ARMAMENT TRAPS AND HOW TO GET OUT OF THEM: LESSONS FROM RESEARCH ON DOVES

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ABSTRACT: Organisms often choose small but immediate rewards over large but delayed rewards, to their long-term detriment. When nations choose to arm for immediate relative advantage over an opponent even though disarming could lead to large but delayed benefits for both parties, their behavior may be understood in this light. Behavioral research with pigeons and humans suggests that the trap-like effects of small immediate rewards can be avoided by arranging delays before the critical choice, or by providing a commitment response that precludes temptation by the small immediate reward. Other methods that have been shown to be effective include signaling the availability of the large reward during the delay, and rewarding alternative behavior that is compatible with choices of the large delayed reward. Applications of these experimental findings to the behavior of nations are suggested, and strategies for avoiding armament traps and acting for the long-term common good are proposed.

## Introduction

Traps arrange small payoffs (bait) and large costs (being caught). They are effective because of the temporal sequence of the outcomes: The small payoff is relatively immediate, and the large cost is relatively delayed. The tendency for nations to arm themselves in the interest of immediate advantage over others, despite the long-term costs of diversion of resources from other pressing problems, economic decline, and military insecurity as other nations do likewise, suggests that nations are enmeshed in armament traps.

Traps come in both one-shot and recurring versions. In a one-shot trap (exemplified by an animal trap), the delayed cost cannot be experienced until it is too late to affect the behavior of entering the trap, and the victim never gets another chance; so, normal learning processes cannot operate. In a recurring trap, there are repeated opportunities to choose, but the adverse consequences may not be experienced until after many choices of the immediate small payoff have been made.

Traps also come in individual and social versions. In an individual trap, both the immediate payoff and the delayed cost affect only the individual who is exposed to the trap. Smoking and other forms of addictive behavior exemplify recurring individual traps: For a smoker, the taste of tobacco and relief from nicotine craving make continued smoking probable despite the likelihood of eventual cancer or heart disease. However, if other factors (such as the Surgeon General's warning or family pressure) make the smoker quit, he or she can experience the long-term consequence of health.

In a social trap, the immediate payoffs for each individual lead to delayed costs for all participants in the system. Commuting by car exemplifies a recurring social trap: For car owners, the conveniences of individual travel from outlying

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areas insure that many people will drive to work despite the resulting traffic jams, air pollution, and eventual global warming. A commuter who refrains from driving not only foregoes convenience in getting to work but also experiences the adverse consequences of driving by others, so there is no long-term payoff, such as clean air, to compete with the short-term payoff of convenience unless large numbers of other commuters also refrain from driving. Accordingly, social traps are especially pernicious.

Costanza (1984) proposed that the nuclear arms race between the superpowers during the cold war could be analyzed as a recurring social trap. He used the dollar auction game devised by Shubik (1971) as a model of the arms race, where bidding for the dollar represented building weapons to enhance national security. At the end of the game, the dollar goes to the highest bidder, who must pay the amount bid—even if it is over $1.00—and the second-highest bidder must also pay even though he gets nothing in return. Thus, the game shifts from trying to get the dollar for a bid that is less than $1.00 to avoiding the position of second-highest bidder. Although bidding may be advantageous at first, continued bidding results in progressively greater costs to both parties, analogous to diminished security and economic disadvantage despite ever-greater investment in arms. In both the game and the arms race, the gradual shift from individual payoffs to mutual costs, coupled with the immediate relative improvement for each bidder resulting from each bid, make for an especially powerful trap. The argument is not confined to superpower arms competition, but applies as well to armament decisions by all competing nations.

Costanza (1984) also used the dollar-auction model to suggest ways out of the arms-race trap. He considered the establishment of a superordinate authority to regulate the game as a solution to the superpower arms race, but ruled it out as improbable because this would require an effective world government. He then suggested that arms escalation could be prevented by a "weapons tax" that would raise the immediate cost of building weapons as a counterpoise to the immediate payoff. He proposed that such a tax could be imposed by the non-nuclear powers and enforced by economic sanctions. However, the weapons-tax notion is similar to the world-government approach in that it requires third-party intervention. Here, we consider some alternatives suggested by the experimental study of "self-control" that may be effective without intervention by a powerful third party.

## Experimental Analysis of "Self-Control"

The problem of self-control arises in situations that pit small immediate reinforcers for one response against larger delayed reinforcers for an alternative response. Although there may be no explicit punishers, both alternatives entail at least implicit or relative punishment: Choice of the small immediate reinforcer fails to maximize reinforcement, and choice of the large delayed reinforcer entails continued deprivation for the duration of the delay after choice. An organism is said to exhibit self-control if it tends to choose the latter. Thus, the situation is a trap as characterized above, and "self-control" is behavior that escapes or avoids the trap.[1]

Logue (1988) has reviewed a wide variety of studies of self-control or "delay

of gratification" with adults, children, rats, and pigeons as subjects. She argued that despite the differences in procedures and species, some common factors that affect choices between small immediate and large delayed reinforcers can be identified. Here, we describe a standard experimental paradigm for the study of self-control with pigeons as subjects and identify some variables that influence choice in this situation. Then, we will discuss the relation of the pigeon paradigm to armament decisions confronting nation states, and suggest ways to make it more likely that nations will engage in self-control and thereby escape or avoid armament traps.

Our use of the pigeon to model nation-state behavior is admittedly playful. The pigeon and the dove are members of the same family, and the standard research pigeon—the white Carneau—is, like its cousin the white dove, a splendid symbol of peace. But our choice is also quite serious. Humans are unlikely to ascribe rationality to pigeons, and therefore will not be tempted to use the notion to explain successful self-control. It may be equally misleading to use the concept of rationality to explain the behavior of nations.

## A Standard Choice Paradigm

A pigeon is deprived of food, and then placed in a chamber with two pecking keys and a grain feeder. Both keys are lighted simultaneously. If the pigeon pecks the left-hand key, it receives an immediate small reinforcer—2 seconds of access to grain—followed by a 10-second post-food delay. If it pecks the right-hand key, a 6-second delay period ensues, followed by 6 seconds of access to grain. Thus, the total time per trial is equated across keys, but the amount of grain per trial is three times greater on the right. To insure that the pigeon experiences both outcomes, occasional trials are arranged with the left key only, or with the right key only. Nevertheless, the pigeon pecks the left key on every choice trial, day after day. It is trapped by immediate access to food despite experience with the larger amount.

A number of researchers have identified ways to enhance the pigeon's tendency to peck the right-hand key. Perhaps the simplest is to add a common delay before both outcomes. For example, if a 10-second delay is added to both, left-key pecks produce 2-second reinforcers after 10 seconds, and right-key pecks produce 6-second reinforcers after 16 seconds. Under these circumstances, pigeons tend to peck predominantly on the right, large-reinforcer key (Green, Fisher, Perlow, & Sherman, 1981).

This result illustrates the phenomenon of *preference reversal*, which can be used to establish a "commitment" response. For example, Rachlin and Green (1972) arranged a situation in which pigeons could peck either of two "pre-choice" keys, A and B, that produced the opportunity to peck for food rather than food itself. Pecks at key A were followed by the standard choice described above: an immediate 2-second reinforcer for pecking the left key vs. a delayed 6-second reinforcer for pecking the right key. Pecks at key B were followed by the right-hand key only, so that the entrapping choice was precluded. When a 10-second delay intervened between pecks at keys A and B and the following food choices, their pigeons tended to peck key B, in effect avoiding the impending temptation of the immediate small reinforcer and committing themselves to the larger (but still delayed) reinforcer.

Thus, pigeons not only prefer larger (but relatively more delayed) reinforcers to smaller reinforcers when a substantial delay intervenes between choices and their consequences, but also commit themselves to the larger reinforcer by precluding the opportunity for choice of the smaller reinforcer when the delay expires.

Other methods for increasing the likelihood of choice of the larger, more delayed reinforcer are also available. Using the standard choice paradigm described above, Logue and Mazur (1981) trained pigeons to select the larger delayed reinforcer by gradually increasing its delay from 0 to 6 seconds. They then showed that the stimuli during the delay were crucial: Their pigeons' preferences for the larger delayed reinforcer depended upon immediate cues signalling that reinforcer, which could be construed as providing an immediate predictor of the yet-to-be-encountered event.

In a related paradigm, Grosch and Neuringer (1981) arranged a situation in which pecking a key gave immediate access to a less preferred food, whereas refraining from pecking for 20 seconds led to a more preferred food. Their pigeons pecked with short latencies, and thus lost access to the preferred food, on about 95% of the trials. Then, the experimenters provided a separate key that the subjects could peck during the 20-second delay interval, and reinforced every 20th peck with a small bit of a third food. Under these conditions, the pigeons waited for 75-80% of the trials, even after the third food was discontinued. These examples illustrate the importance of stimuli that signal the large delayed reinforcer for subjects that have experienced successful self-control, and the utility of progressive training or of engaging in some alternative behavior that competes with responding for the small immediate reinforcer.

Before moving on to discuss applications of the ideas suggested by the pigeon self-control problem to arms races between nation states, it is worth noting that qualitatively similar findings have been obtained with human adults and children in studies that vary widely in procedural detail. For example, if a special locking cigarette case is given to adults who wish to reduce smoking, they can lock it for several hours immediately after a smoke when the temptation to smoke again is weak, and thereby commit themselves not to smoke later when the temptation to smoke is likely to be strong (Azrin & Powell, 1968). Locking the case is a commitment response, analogous to pecking key B in the study by Rachlin and Green (1972). Relatedly, in situations involving choice between an immediate but less preferred snack and a delayed but more preferred snack, children are more likely to wait for the delayed but preferred snack if instructed to think about something other than food, or a different food, during the delay (e.g., Mischel & Baker, 1975). Thinking about something else is functionally analogous to pecking the alternative key in the study by Grosch and Neuringer (1981). Many other similarities between human and pigeon behavior in situations that pit small immediate reinforcers against large delayed reinforcers are reviewed by Logue (1988). Accordingly, if we view the actions of nation states as functionally equivalent to those of individual pigeons or people, we will at least not be led astray by differences in species or procedural matters.

At the same time, we must note two important differences. First, arms races are social traps, by definition involving two or more parties, and all the pigeon

examples involve individual traps. We are not aware of any systematic studies of social-trap situations with pigeons, so here we must turn to people. Perhaps the most widely studied social trap comes from game theory in the form of the iterated "prisoner's dilemma," in which each of two people is confronted with two choices, one of which ("compete") maximizes individual reinforcement on each trial, but leads to long-term costs over repeated trials if the other person also behaves competitively. The other choice ("cooperate") maximizes reinforcement over the long term for both parties if the other also cooperates. Figure 1a shows the four possible outcomes in such a game and the rank-ordered preference for them. The dilemma arises from the uncertainty of the other party's intentions coupled with the relatively high cost of cooperating while the other party competes. This leads both parties to compete even though cooperation would be more beneficial.

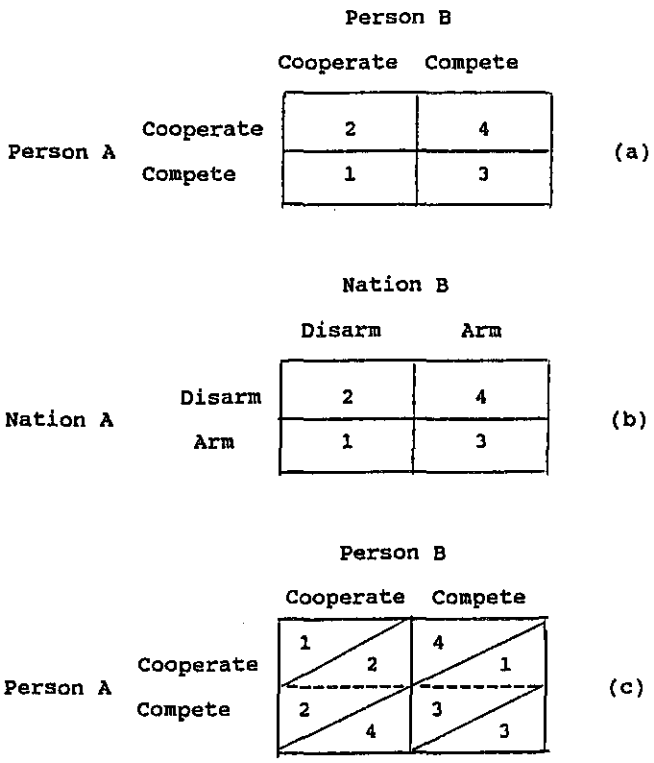


Figure 1. Payoff matrices for the prisoner's dilemma game showing rank-ordered outcome preferences for Person A (a) and Nation A (b). A one-sided prisoner's dilemma (also called a perceptual dilemma) is shown in (c). The top half of each cell represents the rank-ordered outcome preferences for Person A. The bottom half of each cell represents Person A's perceived rank-ordered outcome preferences for Person B.

Axelrod (1984) has shown that a strategy of "tit-for-tat" (i.e., on each trial, make the response that the other person made on the previous trial) is more effective than any other strategy in maximizing gains (or minimizing losses) over many encounters with diverse opponents, but this strategy does not alter the structure of

the trap: The immediate relative gain on each trial remains incompatible with the most favorable long-term outcome. Therefore, the strategy must be supplemented by other methods if each party is to avoid being trapped into competing by immediate reinforcement.

Second, the choices confronted by pigeons in behavioral experiments are repeated again and again under constant conditions, so that the consequences of both alternatives can be experienced. The same is true in virtually all studies of the prisoner's dilemma. By contrast, the choices confronted by nations and the circumstances surrrounding them differ in many ways from one occasion to the next, and history cannot be recycled to provide experience of the consequences of the choice not made.

Because history cannot be recycled, the behavior of an individual nation in a particular situation cannot be selected by the experienced consequences of different courses of action, and may therefore depend in part on rules derived from the history of other nations. The relevant rule for the behavior of arming is "If you want peace, prepare for war." As stated here, this rule is attributed to the Roman general Vegetius, but its message is probably as old as human history.

Despite its venerable status, there is reason to believe that the rule is misleading. Singer (1985) has reported the results of a careful historical analysis of militarized disputes and wars since 1816, and has related the effectiveness of preparing for war (operationalized as military expenditures and size of armed forces) to success in avoiding or prevailing in disputes and wars. His main findings are summarized in Table 1, which characterizes the correlations between military preparedness and the presumably desirable goals of 1) minimizing involvement in militarized disputes; 2) prevailing if the dispute cannot be avoided; 3) staying out of war; and 4) winning if war cannot be avoided. Table 1 suggests that military preparedness is effective (i.e., positively correlated with a desired outcome) only for those nations that either seek war or see no alternative to war in pursuit of their objectives (as may now be the case in the former Yugoslavia).

Table 1

*Summary of correlations between military preparedness and successful outcomes in militarized disputes and wars (adapted from Singer, 1985).*

| | | Nature of Conflict | |
|---|---|---|---|
| | | Militarized disputes | War |
| Outcome | Avoid | Negative | Negative |
| | Prevail | Negative | Positive |

Presumably, the historical record is not unknown to policy-makers. Why, then, is military preparedness so avidly sought by the overwhelming majority of

nations? Glenn (1988) has suggested that "A cultural practice [such as preparing for war] may produce increasingly ineffective outcomes but continue occurring because the behavior of its individual participants is maintained by stable *behavioral* contingencies" (p. 170, italics in original). With respect to arming, the behavioral contingencies affecting individuals include prestige and power for military officers, profits for arms manufacturers, and jobs for defense workers. One approach to changing the cultural practice of arming, then, is to alter these individual contingencies—a political task of daunting complexity, exemplified by President Clinton's inability (or unwillingness) to cancel weapons systems such as the Seawolf submarine that have no military mission in the post-cold-war world. An alternative is to point out conditions under which alternative cultural practices may produce effective outcomes. Here, we extrapolate from the literature on self-control to suggest some ways in which nations can stay out of armament traps despite the pervasive cultural practice of arming and the behavioral contingencies supporting it.

## Applications

The essence of the armament trap is that each of two (or more) competing nations squander their resources on weapons in order to achieve individual, immediate advantage relative to others (small immediate reinforcers), as opposed to refraining from arming in order to achieve long-term mutual security and well-being (large delayed reinforcers). In that sense, their behavior is functionally similar to that of pigeons in the standard experimental situation described above.

Figure 1b shows the rank-ordered preference for outcomes in a theoretical game involving weapons competition between two nations. Arming and disarming (or not arming) initiatives are equivalent to competing and cooperating, respectively. In theory, each response is based on the values or costs of the outcomes and the perceived probability of the other nation's responses. The rational organism will choose the response with the higher expected utility (von Neumann & Morgenstern, 1944; Schoemaker, 1982), which can be represented mathematically as:

$$EU(\text{A arms}) = p(\text{B arms}) \times V(\text{A arms, B arms}) + p(\text{B disarms}) \times V(\text{A arms, B disarms}) \quad (1a)$$

$$EU(\text{A disarms}) = p(\text{B arms}) \times V(\text{A disarms, B arms}) + p(\text{B disarms}) \times V(\text{A disarms, B disarms}) \quad (1b)$$

where EU is expected utility, p is probability, V is the value (positive or negative) of the outcome, and A and B are two nations. Given the peculiar order of outcome preferences shown in Figure 1b (the prisoner's dilemma), each side is constrained to arm irrespective of the perceived probabilities of the other side's intentions.

If, instead, mutual disarmament is the most preferred outcome, then disarming has greater expected utility provided that the probability of the other side's arming is sufficiently low. If the probability is high, then this would be a case in which the value of arming (in the form of security) would be greater than the delayed value of not arming (in the form of economic gains): If arming by the other side

leads to war, the delayed outcome for not arming could be domination by the other side rather than economic gain.

As noted above, history suggests that successful outcomes are positively correlated with military preparation only when war cannot be avoided. Thus, this case may be relevant to small powers that cannot avoid an all-out war, but it is not relevant to nuclear war between the superpowers because of the enormous costs associated even with "winning" a nuclear war. For the superpowers, the problem is avoidance of the armament trap rather than a desperate struggle for military survival in an all-out war.

The pigeon data on preference reversal and commitment suggest that in order to avoid the armament trap, choices should be made well in advance of critical events, and that they should be designed to preclude selection of a tempting but counterproductive alternative that may arise later. An example of advance decision-making, analogous to inserting a delay before confronting a critical choice, is a provision of the SALT I Treaty negotiated in 1972 by the US and the USSR that imposed a period of five years before reviewing its prohibitions on the further development of ballistic missile defenses. Another is the multinational decision to ban nuclear weapons from space, which was made well in advance of technical capabilities for space-based weaponry and then codified in the Outer Space Treaty of 1967. As such, the treaty was a commitment response designed to prevent the costly and destabilizing development of space-based weapons that was relatively easy to make when the technical means (temptation) were not available.

Costanza (1984) proposed a "weapons tax" to reduce the probability of arming. In the pigeon experiment, this would be like arranging an immediate punisher—say, brief electric shock—for choices of the small immediate reinforcer. A nonaversive alternative that is consistent with the pigeon studies (especially the work of Grosch & Neuringer, 1981) is to reinforce behavior that is compatible with long-term disarmament, thereby making the "disarm" choice more likely even though its long-term consequences have yet to be experienced. The advantage is that this can be arranged by the competing parties without the reciprocal threats that would be required to implement punishment for arming. The "Kennedy experiment" (Etzioni, 1967) exemplifies this approach. In 1963, President Kennedy announced the unilateral suspension of atmospheric nuclear testing. Soviet Premier Kruschev reinforced Kennedy's initiative by announcing the curtailment of long-range bomber production, followed shortly by suspension of Soviet nuclear testing. A series of reciprocal steps ensued, including some agreements in the United Nations, negotiations on commercial flights between New York and Moscow, and grain sales to the USSR. None of these steps led to full-scale disarmament (needless to say), but each was effective in both prompting and reinforcing comparable steps by the other party. Equally important, all of these steps were incompatible with short-term military advantage, but instead were compatible with long-term mutual security and economic well-being. The effectiveness of Kennedy's initiative as a signal for the availability of mutual, relatively immediate reinforcement for behavior that is compatible with long-term goals is consistent with the pigeon findings described above.

The Kennedy experiment was short-lived but successful in demonstrating that mutual reinforcement for small steps in the general direction of long-term goals could be effective without third-party involvement. Its success probably depended on the preference by both parties for long-term arms reductions and mutual well-being ("peaceful coexistence") over any immediate advantage resulting from further arms increases. This may be seen as an instance of preference reversal. In periods of intense competition and distrust between the superpowers, arming was preferred to disarming, whatever the long-term consequences. However, the Cuban missile crisis presented both parties with the frightening prospect of mutual devastation, in effect bringing the future consequences of persistent arming into the present. Just as the stimuli that signal future outcomes are critical for pigeons' choices of the larger but more delayed reinforcer, the events of October 1962 led to a reversal of the usual preference for arming to achieve superiority over disarming in the interest of mutual security.

Plous (1985) has argued that each party's assumptions about the preferences of the other are crucial. In the conventional prisoner's dilemma, each side values its own immediate military superiority over mutual disarmament. However, if each party prefers long-term mutual disarmament over immediate military superiority but assumes that its opponent prefers immediate military superiority over long-term mutual disarmament, the result is a "perceptual dilemma," where the two parties remain locked in the prisoner's dilemma because of the mismatch of perceived and actual preferences. Figure 1c illustrates this. It is entirely possible that the continuation of the nuclear arms race between the US and USSR after the late 1960s, when each of the superpowers had the means to insure the destruction of its opponent even after a major first strike, resulted from a perceptual dilemma. Indeed, Plous (1985) provides evidence to this effect.

One way to escape the trap is for one side to engage in repetitive small-scale "cooperate" or "disarm" choices, regardless of its opponent's behavior, thereby signaling its actual long-term preferences. Plous (1987) showed experimentally that this method was effective. Students played a 30-trial game against a computer (disguised as a student from another university). Their task was to win as many points as possible to be redeemed for money at the end of the experiment. Half the subjects were shown a payoff matrix in which the payoffs were rank ordered as in Figure 1a (prisoner's dilemma). The actual payoffs were 7, 6, -1, and -7. The other half were shown a payoff matrix in which the payoffs were rank ordered as in Figure 1c (perceptual dilemma). The actual payoffs were 8, 1, -5, and -7; and the perceived payoffs were 7, 6, -1, and -7. The computer was programmed to "arm" for ten trials, and then to play two different strategies. For half of each group, the computer played tit-for-tat for the remaining 20 trials. For the other half, the computer unilaterally "disarmed" for ten trials, and then played tit-for-tat. During the final ten trials, the competitive structure of the tit-for-tat game engendered predominantly competitive "arming" responses for all subjects except those operating under a perceptual dilemma payoff structure and having been exposed to unilateral disarmament. This group overwhelmingly chose to "disarm," demonstrating the value of signals and interactive experience in generating choices consistent with the long-term preferences of both parties.

It appears that President Gorbachev pursued this sort of strategy in the late 1980s, beginning with his unilateral moratorium on underground nuclear tests and continuing with his withdrawals of some conventional forces from the Warsaw Pact nations. The result was major arms-control treaties with the US, which have recently been ratified by Russia in the aftermath of the collapse of the USSR. From the perspective of the pigeon laboratory, Gorbachev's behavior may be construed as providing stimuli signaling the availability of large delayed reinforcers for disarming responses by the US, which eventually made the US likelier to behave in its own long-term interests.

It may be argued that Gorbachev's initiatives were forced by the internal economic and political problems that became clear to the whole world when the Soviet empire collapsed, and that the US responded only when the weakness of its opponent was evident. However, for the purposes of escaping the armament trap and achieving long-term mutual security, the causes of Gorbachev's moves and US responses are beside the point. As we write, the member nations of the Comonwealth of Independent States (CIS) are preoccupied with their economic survival, and are anxious to reassure the US that their most threatening weapons are under tight control while moves are underway to dismantle them. For its part, the US is refraining from any action that would prompt the CIS to invest in maintaining its status as a collective nuclear superpower. During this period of military restraint, long-term political and economic considerations outweigh investments in arms. Thus, preference reversal can operate to permit commitment responses that will remain effective even if relations deteriorate. For example, the US and CIS member states could engage in economic ventures that commit them to interdependence, with the wellbeing of all as a long-term consequence.

## Relevance to Other Nations

We have used the cold-war nuclear arms competition between the superpowers to discuss applications of research on traps because it has shaped the world we inhabit. However, there are many other examples of armament traps and their consequences. For example, during the war between Iran and Iraq in the 1980s, both sides sought and purchased advanced weaponry from the US, which was delivered on a schedule that gave each side alternating periods of short-term dominance over the other (Waas & Unger, 1992). The result was persistent warfare with tens of thousands of casualties. Three years later, Iraq used its military might to seize Kuwait in order to pay off its war debts—including those incurred by arms purchases—through increased oil revenues, which in turn led to the oil embargo and subsequent military attack by the US and its allies. As a result of the Gulf War, Iraq may be on the threshold of collapse—a victim of the armament trap into which it was lured at least in part by the US. Ironically, the US itself has felt the bite of the trap it helped to set, both in its wartime losses and in its need to maintain costly military commitments in the Persian Gulf. Nevertheless, the short-term reinforcers derived from arms sales to Iran and Iraq during the 1980s, and more recently to Saudi Arabia, seem likely to keep the US trapped in the role of arms supplier to the Persian Gulf, with the resulting access to oil supplies that are necessary to fuel its energy-

hungry lifestyle. However, the regional instability and increased potential for war that result from arms sales may ultimately have the effect of restricting rather than maintaining US access to oil.

## Conclusion

Behavioral studies suggest that the widespread tendency to be trapped into choosing a small immediate reinforcer when a large delayed reinforcer is available for some alternative behavior can be reduced in several ways: 1) insert a delay before the choice must be made; 2) provide a commitment response that precludes choice of the alternative leading to small immediate reinforcers; 3) provide experience with successful choices of the large delayed reinforcer; 4) signal the availability of the large reinforcer during the delay; and 5) reinforce behavior that is compatible with choice of the large delayed reinforcer. These principles underly methods that produce shifts from competition to cooperation in two-person games, and can be used to describe the practices of nations in armament traps. Knowledge and application of these principles may facilitate escape from such traps. Their application will be reinforced by the long-term security and well-being that result.

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## NOTE

1. We shift here from the terminology of payoffs and costs to that of reinforcers and punishers for two reasons. The former terms suggest an economic calculus that may be misleading, and the latter standard in behavioral analyses, where they are defined by their effects on behavior rather than their intuitive hedonic or economic value.