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The environmentalist who cried drought: Reactions to repeated warnings about depleting resources under conditions of uncertainty

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A B S T R A C T

Three studies examined the impact of warnings about depleting resources. In Study 1, participants played 16 trials of a 5-person resource dilemma game with complete resource uncertainty. After trial 12, participants were told they were close to depleting the resource, and thereafter received no additional warnings. Size of harvests dropped after the warning, but rebounded within 3 trials to pre-warning levels, a pattern stronger under low harvesting variability. In Study 2, participants received warnings after trials 12 and 16 of a 22-trial game. Again, harvesting dropped after the first warning, but rebounded to pre-warning levels within 3 trials, a pattern stronger under a short-term vs. a long-term warning. Harvesting was unaffected by the second warning. In Study 3, when participants received no feedback about others' harvests, harvesting dropped after both warnings, and was lower among those led to believe the resource would last a short number of trials.

1. Introduction

Frequently, environmental problems are framed as *social dilemmas*, commonly defined as situations in which short-term personal interests are at odds with long-term collective interests (Joireman, 2005; Komorita & Parks, 1994; Messick & Brewer, 1983). Arguably, one of the most important dilemmas we face is the depletion of natural resources (Stern, 1992). From a social dilemma perspective, depletion of natural resources occurs because people maximize their own short-term interests while failing to consider the long-term impact of their actions on society or the planet. One possible solution to this problem, often played out in the media, is to warn the public that resources are depleting at an unsustainable rate, and to encourage the public to conserve those resources. One potential problem with this approach is that, because the actual state of many resources is uncertain, the public must have faith that the warning is accurate, the crisis is imminent, and that reducing consumption is necessary for the long-term health of the resource. Ironically, a related problem is the fact that such warnings are intended to preserve the *long-term* health of the resource. In other words, while the warnings could very well be accurate, most resources are unlikely to disappear tomorrow. As such, the public must endure repeated warnings about the possible depletion of a natural resource, even in the absence of a catastrophe. This raises the question, if the public is warned repeatedly about the potential demise of a resource while, for all practical purposes, the resource remains intact, does the effectiveness of those warnings decrease, just as people eventually ignored the boy who cried wolf? Moreover, do responses to initial and repeated warnings vary as a function of others' harvesting requests, the short-term vs. long-term nature of the warnings, and/or individual differences relevant to decision making in social dilemmas? Below, we review work on decision making in social dilemmas relevant to these questions and report a series of three studies testing several hypotheses derived from our analysis.

1.1. Modeling resource consumption in the lab

Researchers interested in studying the depletion of natural resources in the lab have often employed experimental analogues known as resource dilemma games (RDGs) (Komorita & Parks, 1994; Kopelman, Weber, & Messick, 2002). While the resource can be framed in terms of actual resources, like fish (Hine & Gifford, 1996), oftentimes it is simply presented as a common pool of points. In the standard RDG, decision makers first decide how many points to request (or "harvest") from a common pool. Once all requests have been deducted from the common pool, the remaining points are multiplied by a replenishment rate to arrive at a pool size for the next trial. Before making their requests, decision makers are typically given some information about the size of the resource. In some cases, decision makers are given an exact pool size, whereas in other cases, decision makers are given a range of possible pool sizes.

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Following the first trial, decision makers are also often provided with information about the choices of others.

As we review below, past research using the standard RDG has revealed a number of important and interesting findings. At the same time, the standard RDG possesses certain features that may limit its generalizability to real-world settings. One particularly interesting feature of the standard RDG that deviates from resource dilemmas in the real world is the provision of pool size information, whether it be an exact pool size, or a range of possible pool sizes. Providing this information makes good sense at one level, as it seems strange at first glance to ask decision makers to manage a resource they know nothing about. On the other hand, decision makers in real-world resource dilemmas rarely have much if any reliable information about the size of the resource in question. We frequently hear, for example, that oil reserves are declining and might soon run out, but accurately estimating the amount of oil remaining on the planet is a difficult task. Uncertainty concerning the size of a common resource is important, because past research has consistently shown that people harvest more from a common resource as the uncertainty of the resource increases (e.g., Budescu, Rapoport, & Suleiman, 1990; Budescu, Suleiman, & Rapoport, 1995; Gustafsson, Biel, & Gärling, 1999; Hine & Gifford, 1996; Roch & Samuelson, 1997).[1] Given this, understanding decision making in resource dilemmas can be advanced by mimicking resource uncertainty in the lab.

1.2. Decisions under uncertainty

How might people go about making harvesting decisions under resource uncertainty, and what factors might influence their harvesting decisions under these conditions? In an early set of studies, researchers suggested that harvesting in resource dilemmas is driven by three key motives: namely, a desire to use the resource responsibly, a desire to harvest as much as possible, and conformity to group norms (Messick et al., 1983; Samuelson, Messick, Rutte, & Wilke, 1984). Based on these motives, and subsequent reviews (Van Dijk, Wit, Wilke, & Budescu, 2004), we identify four factors that are likely to influence how people make decisions in resource dilemmas characterized by uncertainty. First, it is likely that people will look to an expert who can give advice about appropriate (responsible) harvesting behavior. Second, people are likely to use others' behavior as a cue as to the appropriate harvest (based on the conformity motive). Third, people are likely to draw on pre-existing individual differences relevant to decision making in resource dilemmas (which will impact how people balance the conflicting motives of using the resource responsibly and harvesting as much as possible from the resource). Finally, people are likely to base their harvest decisions on cognitive heuristics about the longevity of the resource (which can impact the extent to which people will believe it is important to cut back and harvest responsibly). We first consider the main effects of these variables, and then consider how information about others' harvests, individual differences, and cognitive heuristics might moderate the impact of warnings on harvesting. In developing our hypotheses, we restrict our focus to the main effect of warnings, and the interaction between warnings and the four variables just outlined.

1.3. Warnings in a resource dilemma

In the real world, decision makers faced with complete resource uncertainty must, to a large extent, rely on experts to make estimates about the size of various resources. In the lab, one reasonable "expert" is the researcher running the study. While decision makers might have no information about the size of the resource, they are told that the researcher does have access to this information. Assuming that one goal of decision makers is to preserve the life of the resource, the researcher could potentially have a large impact on harvesting decisions by introducing a warning about the declining state of the resource.

In fact, several studies have shown that when people receive detailed information about the long-term consequences of their behavior they show greater restraint in experimentally created resource dilemmas (Schroeder & Johnson, 1982; Stern, 1976) and real-world conservation tasks (Thompson & Stoutemyer, 1991). Additional research suggests that while spot messages reminding decision makers of the long-term value of resource conservation are not effective (Stern, 1976), *crisis messages* can be effective in helping people to conserve a common resource if paired with empowering messages that reinforce people's conservation behavior (Vasi & Macy, 2003). Building on this prior work, we expected that warnings about a declining resource would encourage people to reduce their harvests.

Hypothesis 1: Warnings will reduce harvesting behavior.

We also examined whether the effectiveness of warnings would change over time, and whether warnings stressing an immediate crisis would be more effective than warnings suggesting that a possible crisis might eventually develop. To mirror many real-world situations, our warnings provided no post-warning feedback about the success or failure of people's presumed conservation behavior. As such, it seemed likely that people may become less responsive to warnings over time, either because they did not believe the person giving the warning, they saw no connection between their resource conservation and any meaningful outcome, or because they felt they had already sacrificed enough for the common good. It also seemed reasonable to assume that warnings stressing an immediate crisis would be more effective than those that suggested that a crisis might eventually develop.

Hypothesis 2: Initial warnings will be more effective than subsequent warnings.

Hypothesis 3: Warnings stressing an immediate crisis will be more effective than warnings that suggest a crisis may eventually develop.

1.4. Impact of others' behavior

Just as people are likely to look to leaders for advice under uncertainty, they are also likely to base their decisions, in part, on the behavior of others. It has long been known, for example, that people reciprocate the behavior of others in the prisoner's dilemma (Kuhlman & Marshello, 1975) and in resource dilemmas (Schroeder, Jensen, Reed, Sullivan, & Schwab, 1983; Wilke & Braspenning, 1989). Also relevant, past research has shown that people harvest more as the *variability* of others' harvests increases (Jorgenson & Papciak, 1981; Messick et al., 1983). As such, we expected that people would harvest more as the variability of others' harvests increased.

1.5. Differences in social and temporal concerns

As weak situations, dilemmas characterized by uncertainty are also likely to allow for the expression of individual differences (cf. de Kwaadsteniet, van Dijk, Wit, & de Cremer, 2006; Roch & Samuelson, 1997; Snyder & Ickes, 1985). In the present study, we focus on the role of individual differences in social value orientation

[1] Technically, the main effect for variability in the Roch and Samuelson (1997) study was only marginally significant, but the means were in the same direction as those reported in the remaining studies cited here.

(SVO; Messick & McClintock, 1968) and the consideration of future consequences (CFC; Strathman, Gleicher, Boninger, & Edwards, 1994), given their relevance for the social and temporal conflicts underlying the vast majority of social dilemmas (Joireman, 2005).

1.5.1. Social value orientation

All social dilemmas involve a social conflict between individual and collective interests. As such, individual differences in concern with own and others' well-being (i.e., social value orientation; Messick & McClintock, 1968; Van Lange, Otten, De Bruin, & Joireman, 1997) are likely to impact harvesting decisions. Indeed, many past studies indicate that individuals with a prosocial orientation (those who value joint gain and equality) are more likely than those with a proself orientation (those who value own gain and relative advantage over others) to cooperate in a variety of social dilemma settings, including resource dilemmas (e.g., Kramer, McClintock, & Messick, 1986; Parks, 1994; Roch & Samuelson, 1997). Consistent with this past work, we expected proselfs to harvest more than prosocials.

1.5.2. Consideration of future consequences

Beyond the mandatory social conflict, most social dilemmas also involve a temporal conflict between short-term and long-term interests (Hendrickx, Poortinga, & van der Kooij, 2001; Joireman, 2005; Kortenkamp & Moore, 2006; Messick & Brewer, 1983). Directly relevant to the temporal conflict are individual differences in CFC, which are conceptualized as the extent to which people consider the future outcomes of their behavior (Strathman et al., 1994). People low in CFC consider the immediate more than the delayed consequences of behavior, whereas those high in CFC consider the delayed more than the immediate consequences of behavior.

Because resource dilemmas play out over time, and because short-term thinking can lead to long-term disaster (Messick & Brewer, 1983), individuals high in CFC should be more likely to show restraint when managing a common resource (cf. Mannix, 1991). Indeed, CFC has been shown to play a role in decision making about resource dilemmas. For example, in their original article, Strathman et al. (1994) found that high CFCs were less supportive than low CFCs of a proposal for offshore drilling when the long-term consequences of drilling were clearly negative. More recently, Kortenkamp and Moore (2006) had participants read about hypothetical resource dilemmas where the negative consequences of defecting were presented at varying delays (0–120 years). Kortenkamp and Moore (2006) found that CFC moderated the relationship between environmental attitudes and cooperation such that those high in both environmentalism and CFC continued to cooperate across time, but all other combinations of environmentalism and CFC reduced their cooperation rates over time. In sum, theory and research suggest that those low in CFC will harvest more than those high in CFC.

1.6. Cognitive heuristics: anchoring and adjustment

When faced with uncertainty about the size and/or duration of a resource, people are also likely to utilize heuristics to guide their decision making (Biel & Gärling, 1995; Roch, Lane, Samuelson, Allison, & Dent, 2000; Van Dijk, Wilke, Wilke, & Metman, 1999). As people attempt to estimate the size and longevity of a resource, one heuristic that people are likely to use is the anchoring and adjustment heuristic (Tversky & Kahneman, 1974). When using the anchoring and adjustment heuristic to estimate numbers (e.g., the number of trials a resource will last), people first focus their attention on an initial anchor point, often provided by an experimenter. Once established, people then adjust away from that anchor point, but fail to adjust sufficiently, resulting in estimates that are biased in the direction of the original anchor.

In the present work, we explored how the anchoring and adjustment heuristic might influence people's estimates about the longevity of the resource and their harvesting behavior. Just as beliefs about the size of a resource can impact people's consumption, we assumed that people's beliefs about the longevity of the resource would also affect their harvesting decisions. If a person believes a resource is likely to last into the distant future, conservation is unnecessary, and one can harvest a large amount without any threat of destroying the commons. If, on the other hand, one assumes the resource may last only a few trials, conservation becomes more important. Based on this reasoning, we assumed that people given an initially high trial length anchor would harvest more than those given an initially low trial length anchor.

1.7. Interactions: moderators of warnings' effectiveness

Complementing our focus on main effects, we also conjecture that variance in others' harvests, individual differences, and cognitive heuristics are likely to moderate the impact of warnings on harvesting behavior. In short, we expect that people will be more responsive to warnings when the variability of others' harvests is low, when people posses a prosocial orientation, when people are concerned with the delayed consequences of their actions, and when people are initially led to believe that the resource will not last long.

Following a warning, we assume that a salient norm is to reduce one's harvest requests. Conformity to this norm, however, is likely to depend on a variety of factors. First, the conformity motive should be weaker when the variability of others' harvests is large (e.g., Messick et al., 1983) perhaps in part because it would be less obvious that one had violated the norm to reduce harvests. Accordingly, we predicted that response to the warning would be stronger when the variability of others' harvests was small as opposed to large. Second, because they are concerned with others' well-being, prosocials should be more responsive to a warning that the collective resource is threatened; in fact, at least one study shows this pattern of reduced harvesting in response to a declining resource (Kramer et al., 1986). Third, people who are concerned with the long-term consequences of their actions should be more responsive to warnings, as warnings indicate that the long-term health of the resource is threatened. Consistent with this hypothesis, past research shows that when people are fully aware of the negative impact of their behavior on the environment, high CFCs show increases in proenvironmental inclinations whereas low CFCs seem to be relatively insensitive to the long-term consequences associated with environmental problems (Joireman, Van Lange, & Van Vugt, 2004; Kortenkamp & Moore, 2006; Strathman et al., 1994). Finally, we anticipated that those initially led to believe that the resource would not last long (via a low cognitive anchor) should be more convinced of the seriousness and validity of the warning, and consequently, should show greater reductions in harvesting in response to the warning. While intuitively appealing, we are not aware of any empirical work that has looked at this specific question. In sum, we advanced the following interaction hypotheses.

Hypothesis 4: People facing low variability in others' harvests will be more responsive to the warnings than those facing high variability in others' harvests.

Hypothesis 5: Prosocials will be more responsive to the warnings than proselfs.

Hypothesis 6: High CFCs will be more responsive to the warnings than low CFCs.

Hypothesis 7: People led to believe that the resource will not last long will be more responsive to the warnings than those led to believe the resource will last a long time.

1.8. Overview of studies

To test these hypotheses, we conducted three studies. In Study 1, we evaluated the impact of a single warning and manipulated variability in others' harvests. In Study 2, we held variability in others' harvests constant, introduced a second warning and manipulated the urgency of the warning. In Study 3, we again presented two warnings and we manipulated whether people initially believed the resource would last for few or many trials.

2. Study 1: single warning under low vs. high harvesting variability

2.1. Method

2.1.1. Participants and procedure

Introductory psychology students ($N = 90$) participated in partial fulfillment of a course requirement. Participants arrived at the lab in groups of 5, where they were seated at individual cubicles. Participants first completed a set of individual difference measures and subsequently played a 16-trial resource dilemma game. Following the game, participants were thanked, debriefed, and dismissed.

2.1.2. Individual difference measures

Participants first completed a set of 9 decomposed games designed to assess individual differences in social value orientation (Van Lange et al., 1997). As an example, in one game participants chose among three options offering points to Self and Other: *Option A* = 480 points to Self, 80 points to the Other (i.e., a competitive choice, as it maximizes the relative gain between one's own and the other's outcomes); *Option B* = 540 points to Self, 280 points to the Other (i.e., an individualistic choice, as it offers the highest gain to self); *Option C* = 480 points to Self, 480 points to the Other (i.e., a prosocial choice, as it offers the highest joint gain, highest other gain, and smallest difference in self-other outcomes). To be classified, participants had to demonstrate a consistent preference for one of the three orientations in at least six of the nine games. Of the 90 participants, 86 were classifiable, including 38 prosocials and 48 proselfs (i.e., individualists and competitors; Kramer et al., 1986).

Participants next completed Strathman et al.'s (1994) 12-item Consideration of Future Consequences scale. The CFC scale includes general statements regarding a person's tendency to take into account the immediate vs. future consequences of his/her behavior, none of which deal with specific topics that might confound the results. Specifically, no items deal with involvement in pro-environmental behavior, per se. Participants rated the 12 items on a scale from 1 (extremely uncharacteristic of me) to 7 (extremely characteristic of me). The CFC scale was highly reliable in the current study ($\alpha = .84$).

2.1.3. Resource dilemma game

Once they had completed the decomposed games and CFC scale, participants played 16 trials of an RDG, during which they were not allowed to communicate with the others in the room. The game was introduced via a water consumption analogy, and a written numerical example of the replenishment process was provided and read to participants. However, no information about the regeneration rate was provided to participants. In addition, participants were told that the goal of the game was to accumulate as many points as possible while still maintaining the resource over the long-run, but no monetary incentives were offered based on performance. To prevent end-game behavior (Komorita & Parks, 1994), participants were not informed about how many trials they would actually play. Following past research, we restricted the number of points participants could harvest from the common pool (e.g., Messick et al., 1983; Roch & Samuelson, 1997; Samuelson & Messick, 1984; Samuelson et al., 1986). On any given trial, participants indicated on a slip of paper how many points, from 0 to 20, they wanted to harvest from the common resource. Slips were collected by an experimenter who then returned to her desk, ostensibly to do some calculations based on the harvest requests. Participants were informed that the resource pool would be regenerated by adding back into the pool a certain percentage of the remaining points. Prior to trial 13, the experimenter delivered a standardized warning, stating: "This is a warning that you are dangerously close to depleting your resource. Please make your next choice." Participants then played 4 additional trials, after which the experimenter announced that the game was over. Participants were then thanked, debriefed, and dismissed.

2.1.4. Harvesting variability manipulation

In contrast to the standard resource dilemma paradigm, participants received no information about the size of the resource throughout the game. Participants did, however, receive false feedback before each trial about the range of harvests of other participants on the preceding trial. In both variability conditions, the mean harvest varied from trial to trial but remained constant across the variability conditions, with an average harvest of 12.20. In the *low variability condition*, the difference between the lowest and highest harvesters ranged between 2 and 4 points (average range = 3.25). In the *high variability condition*, the difference between the lowest and highest harvesters ranged between 14 and 16 points (average range = 14.94).

2.2. Results

Prior to analysis, scores on the CFC scale were submitted to a median split, and harvest requests on the 16 trials were converted into 5 trial blocks. Blocks 1–3 consisted of the average harvest across trials 1–4, 5–8, and 9–12, respectively. Block 4 consisted of the harvest on trial 13, the trial immediately following the warning. Block 5 consisted of the average harvest across the remaining post-warning trials, 14–16.

2.2.1. Global analysis

Using these five trial blocks, we conducted a 2 (Harvesting Variability: low vs. high) × 2 (CFC: low vs. high) × 2 (SVO: prosocial vs. proself) × 5 (Trial Block) mixed-model analysis of variance with repeated measures on the last factor. This analysis revealed a significant main effect for SVO, F (1, 77) = 6.33, $p < .02$, $\eta^2 = .08$, a marginally significant main effect for variability condition, F (1, 77) = 3.40, $p = .07$, $\eta^2 = .04$, and a significant main effect for trial block, F (4, 74) = 14.26, $p < .001$, $\eta^2 = .44$ (remaining $ps > .13$). As anticipated, proselfs (M = 12.91, SD = 3.92) harvested significantly more than prosocials (M = 10.87, SD = 3.89), and those in the high variability condition (M = 12.76, SD = 4.09) harvested more than those in the low variability condition (M = 11.27, SD = 3.85). Means for the trial block main effect are displayed in Fig. 1. As can be seen, prior to the warning, harvesting increased from block 1 through block 3. Immediately after the warning, on trial 13 (block 4), harvests dropped, but then rebounded to pre-warning levels during the remaining (block 5) trials. More details concerning these differences are provided following a discussion of the trend analyses.

2.2.2. Trend analysis

No other effects were significant at the global level. However, given the non-linear pattern of the trial block effect, a trend analysis examining the linear, quadratic, and cubic trends appeared

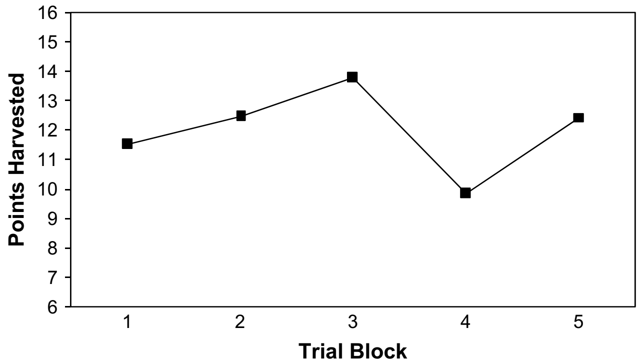

Fig. 1. Points harvested as a function of trial block (Study 1).

warranted, as this analysis would provide more precise insights into the exact nature of the trial block effect. For example, as can be seen in Fig. 1, the general trend for the trial block variable is a cubic trend, with means increasing from block 1 through block 3, then decreasing, then showing a rebound. Though less noticeable, a partial u-shaped function is also apparent in Fig. 1, suggesting a lower order quadratic trend as well. Given that both trends were theoretically relevant to the study at hand, and given that the individual (1-df) trend analysis effects are more powerful than the global (4-df) main effects test, we submitted the five-level trial block variable to a trend analysis.

The trend analysis revealed several interesting findings. First, this analysis revealed a significant cubic trend on the trial block variable, $F(1, 77) = 22.10$, $p < .001$, $\eta^2 = .22$, as expected based on the pattern shown in Fig. 1.[2] Second, the trend analysis revealed a significant interaction between variability condition and the quadratic trend of the trial block variable, $F(1, 77) = 4.66$, $p < .05$, $\eta^2 = .06$. This interaction indicated that the u-shaped or quadratic portion of the function shown in Fig. 1 differed between variability conditions. An examination of the means, shown in Fig. 2, revealed that the decrease from trial block 3 to trial block 4 and the rebound from trial block 4 to trial block 5 were larger in the low variability condition. Finally, the trend analysis revealed a significant interaction between CFC and the cubic trend of the trial block variable, $F(1, 77) = 6.16$, $p < .02$, $\eta^2 = .07$. An examination of the means, shown in Fig. 3, revealed that relative to high CFCs, low CFCs showed a larger decrease in response to the warning and a larger rebound effect in the last block of trials.

2.2.3. Post hoc comparisons

To provide more insight into the overall trend analyses just reported, we explored the extent to which participants showed a significant reduction in harvests following the warning (block 3 vs. block 4: *warning effect*) and/or a significant increase in harvests following the critical warning trial (block 4 vs. block 5: *rebound effect*). Table 1 summarizes the results of these within-participant comparisons, broken down by the relevant conditions involved in the trend analysis interactions.

As can be seen, overall, participants showed significant warning and rebound effects. Moving down in the table, it can be seen that those in the low variability condition showed significant warning and rebound effects, whereas those in the high variability showed only a warning effect. Finally, it can be seen that those low in CFC showed significant warning and rebound effects, whereas those high in CFC showed only a significant warning effect.

[2] The fourth-order trend was also significant ($p < .001$), though difficult to interpret.

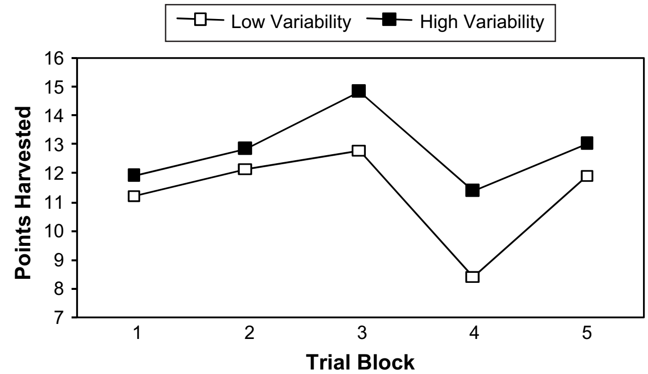

Fig. 2. Points harvested as a function of trial block and variability in others' harvests (Study 1).

2.3. Discussion

The present results provided initial support for several of our hypotheses. As expected, harvesting was reduced immediately after a warning (H_1), and was, on average, higher among those led to believe others had a high amount of variance in harvests, and among proselfs. Moreover, as expected, those in the low variance condition were more responsive to the warning than those in the high variance condition (H_4). Individual differences in CFC also interacted with the warning, but in an unexpected fashion. Counter to our hypothesis (H_6), individuals low in CFC were more responsive to the warning than those high in CFC, presumably because the warning emphasized short-term/immediate consequences. In addition, while prosocials harvested less than proselfs, the two groups did not differ in their responsiveness to the warning.

Another interesting finding was that harvesting rebounded to pre-warning levels within the final trial block. This suggests that when people receive a warning about a depleting resource, they are willing to reduce harvests, but if no other warnings are forthcoming, they assume that the resource is no longer threatened and return to their typical level of (pre-warning) harvesting. An alternative explanation is that over time people may have forgotten the warning. In either case, subsequent warnings may be necessary to maintain the longevity of the resource. Subsequent warnings, however, present their own problems. In particular, if no crisis immediately follows the first warning, as often happens in the real world, subsequent warnings may be less effective than initial warnings. To test this hypothesis, in Study 2, we conducted a replication and extension of Study 1 in which we used a longer series of trials and added a second warning.

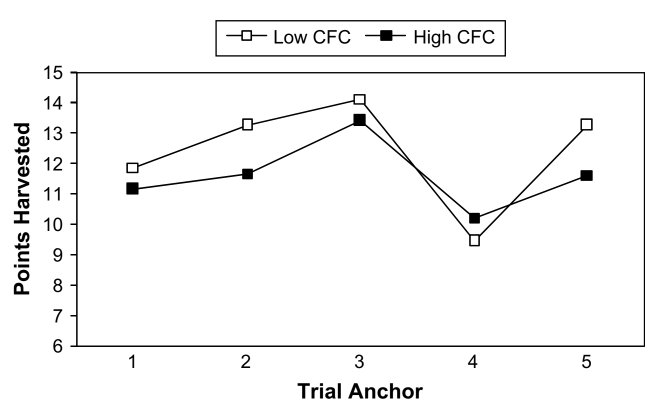

Fig. 3. Points harvested as a function of trial block and consideration of future consequences (Study 1).

Table 1
Warning and rebound effects as a function of condition: Study 1.

Condition	Warning effect	Rebound effect
Overall	.001	.001
Variability		
Low	.001	.001
High	.001	.063
CFC		
Low	.001	.001
High	.001	.086

Note. Values shown are *p*-values for within-participant comparisons. Warning effect = block 3 vs. block 4; rebound effect = block 4 vs. block 5.

We also explored whether the type of warning would influence responsiveness to the warning. In Study 1, the warning emphasized that the resource was on the verge of being depleted, thus emphasizing the short-term consequences of the crisis. In the real world, by contrast, warnings tend to emphasize the long-term consequences of resource depletion (e.g., at the current rate of consumption, oil reserves are likely to run out at some point in the future). Under these circumstances, it is possible to delay worrying about the depletion of the resource. To test this hypothesis, in Study 2, we compared the effectiveness of warnings that emphasized the short-term vs. the long-term consequences of over-consumption. We anticipated that the short-term warning would be more effective at reducing harvests compared with the long-term warning, as the former clearly indicates that a crisis is imminent. We also anticipated that the type of crisis might interact with individual differences in CFC, such that low CFCs would be more responsive than high CFCs to the short-term warning, whereas individuals high in CFC would be more responsive than low CFCs to the long-term warning. We made no predictions concerning the possible interaction between social value orientation and type of warning, as the warnings did not differ in terms of their impact on personal vs. social well-being.

3. Study 2: repeated short-term vs. long-term warnings

3.1. Method

3.1.1. Participants and procedure

Introductory psychology students ($N = 85$) participated in partial fulfillment of a course requirement. The basic procedure used in Study 2 was very similar to that used in Study 1. Participants, seated at individual cubicles, completed the decomposed games and the CFC scale, and subsequently played a resource dilemma game in groups of 5. However, in Study 2, the number of trials was lengthened to 22 to allow for the inclusion of a second warning and all participants received the same bogus feedback concerning the harvesting behavior of others: the average harvest was 12.2, and the range between the lowest and highest harvests was between 7 and 12 points.

3.1.2. SVO and CFC

Prior to the resource dilemma, participants completed the decomposed games measure of SVO and the CFC scale described earlier. Of the 85 participants, 70 were classifiable, including 29 prosocials and 41 proselfs and the CFC scale was reliable ($\alpha = .76$).

3.1.3. Warning manipulation

Participants were randomly assigned to one of two warning conditions. Participants in the *short-term warning condition* were told, "This is a warning that you're close to depleting your resource. At the current rate of use the resource will be depleted very soon. Please make your next choice." Participants in the *long-term warning condition* were told, "This is a warning that you're close to depleting your resource. At the current rate of use the resource will eventually be depleted. Please make your next choice."[3] The respective warnings were delivered after trials 12 and 16.

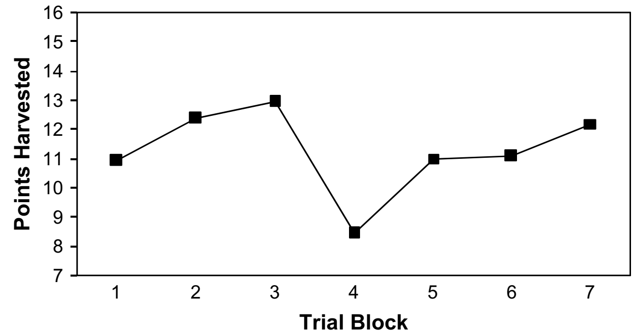

Fig. 4. Points harvested as a function of trial block (Study 2).

3.2. Results

As before, we submitted the CFC scores to a median split, and condensed the 22 trials into a meaningful number of trial blocks. Blocks 1–5 were defined as in Study 1. Block 6 represented the second "critical block" (trial 17) immediately following the second warning, while Block 7 represented the remaining trials following the second warning (trials 18–22).

3.2.1. Global analysis

Once composed, harvest level on the seven trial blocks was submitted to a 2 (Warning Condition: short-term vs. long-term warning) × 2 (CFC) × 2 (SVO) × 7 (Trial Block) mixed-model analysis of variance with repeated measures on the last factor. This overall analysis revealed only a significant main effect for trial block, $F\,(6, 57) = 10.56$, $p < .0001$, $\eta^2 = 53$ (all remaining $ps > .16$). An examination of the means, displayed in Fig. 4, revealed two interesting results: first, results during the first 5 trial blocks replicated the pattern observed in Study 1 (Fig. 1): following the warning, harvesting decreased, and subsequently returned to pre-warning levels after the critical trial. However, as can be seen, harvesting during the sixth block, the critical trial following the second warning, did not decrease, while harvesting during trial block 7 showed a slight increase.

3.2.2. Trend analysis

In keeping with Study 1, we followed up the global analysis with a trend analysis of the trial block variable. This analysis revealed several interesting findings. First, the trend analysis revealed a significant quadratic trend for the trial block variable, $F\,(1, 62) = 7.70$, $p < .01$, $\eta^2 = .11$, as well as a significant cubic trend for the trial block variable, $F\,(1, 62) = 17.76$, $p < .0001$, $\eta^2 = .22$. Second, the trend analysis revealed a significant Warning Condition × Trial Block interaction on the quadratic trend, $F\,(1, 62) = 4.44$, $p < .05$, $\eta^2 = .07$. As can be seen in Fig. 5, relative to those in the long-term warning condition, those in the short-term warning condition showed a larger decrease in harvesting in response to the first

[3] As two anonymous reviewers aptly noted, our use of the phrase "you're close to depleting your resource" might have been taken as a short-term warning. While this is possible, we also note that the next sentence qualifies this phrase by stating that the resource will *eventually* be depleted. We also note that our goal was to create a relative difference between the short-term and long-term warning conditions. Nevertheless, future research could profitably explore how decision makers respond under an even longer-term warning than used in Study 2.

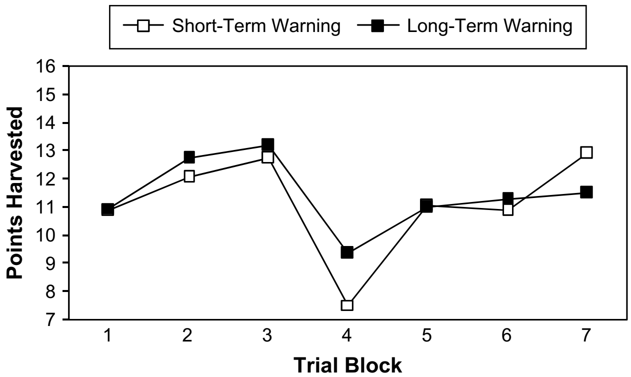

Fig. 5. Points harvested as a function of trial block and type of warning (Study 2).

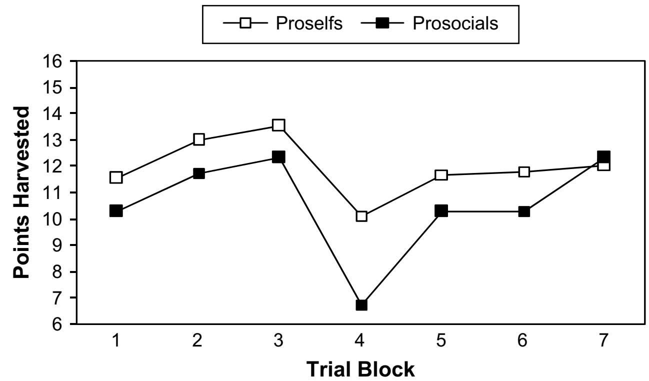

Fig. 6. Points harvested as a function of trial block and social value orientation (Study 2).

warning and a larger rebound following the critical trial, when compared to those in the long-term warning condition.[4]

The trend analysis also revealed a significant SVO × Trial Block interaction on the quadratic trend, $F(1, 62) = 5.28$, $p < .05$, $\eta^2 = .08$. As can be seen in Fig. 6, relative to proselfs, prosocials showed a larger decrease in harvesting in response to the first warning, as well as a larger rebound following the critical trial.

3.2.3. *Post hoc comparisons*

Table 2 summarizes the initial and subsequent warning and rebound effects. As can be seen, overall, there was a significant initial warning and rebound effect, but the second warning and rebound effects were not significant. Also apparent, those in the short-term warning condition showed a significant initial warning and rebound effect, as well as a significant (second) rebound effect. Those in the long-term warning condition showed only a significant initial warning and rebound effect. Finally, proselfs showed a significant initial warning and rebound effect, whereas prosocials showed a significant warning and rebound effect, as well as a significant (second) rebound effect.

3.3. *Discussion*

The present results provided additional support for several of our hypotheses. To begin, as expected, initial warnings were more effective than subsequent warnings at reducing harvests (H_2); indeed, the second warning in the present study was completely ineffective at reducing harvests. Second, warnings emphasizing an immediate crisis were, as expected, more effective at reducing harvests than warnings emphasizing the potential long-term demise of the resource (H_3). Finally, in line with our hypotheses, prosocials were more responsive than proselfs to the first warning (H_5), though neither group was responsive to the second warning. We again failed to find a main effect for CFC, and CFC did not interact with warnings in the present study, in contrast to our Study 1 finding.

In our view, the most interesting finding from this study was the complete ineffectiveness of the second warning. At least three explanations can be offered to explain this result. One explanation is that participants received no feedback about whether their reduction of harvests was effective at averting a crisis. A second explanation is that when no crisis appeared to emerge following the first warning, participants began to doubt the experimenter's warning. A final explanation is that people felt like a sucker for having restrained their harvests while others apparently had not. A close inspection of the feedback given to participants suggests that this is a likely explanation. Specifically, feedback on trial 13 indicated that the average harvest did not differ greatly from earlier trials, which suggests that others in the group had not reduced their harvests in response to the first warning. Thus, when the second warning came, participants acted to ensure that they would not be taken advantage of by the other participants, or simply conformed to the norm set by others in response to the first warning. As this seemed like the most reasonable hypothesis, we evaluated it in Study 3 by removing feedback about others' harvests. If participants respond to the second warning in the absence of feedback about others' harvests, this would lend support to the last line of reasoning. Moreover, it could have potentially important practical implications in real-world resource dilemmas.

Another goal of our third study was to evaluate the impact of cognitive anchors regarding the likely longevity of the resource. As noted earlier, we predicted that people who were led to believe the resource would last a long time would harvest more and be less responsive to warnings compared to those led to believe the resource would not last for many trials.

4. Study 3: repeated warnings under low vs. high trial anchors

4.1. *Method*

4.1.1. *Participants and procedure*

Introductory psychology students ($N = 115$) participated in exchange for course credit. The procedure was identical to the procedure used in Study 2, with three exceptions. First, prior to the resource dilemma game, participants were randomly assigned to one of two trial anchoring conditions. Second, to make the trial anchoring manipulation more meaningful, participants were informed of the size of the initial resource pool (600 points).[5] Third, the type of warning was held constant; all participants receiving the short-term warning described in Study 2 after trials 12 and 16.

4.1.2. *SVO and CFC*

Prior to the resource dilemma game, participants completed the decomposed games measure of SVO and the CFC scale described earlier. Of the 115 participants, 91 were classifiable, including 69 prosocials and 22 proselfs, and the CFC scale was reliable ($\alpha = .86$).

[4] The analysis also showed a significant fourth-order trend for the trial block effect ($p < .0001$) and a CFC × fourth-order trend interaction ($p = .05$), but both were very hard to interpret.

[5] We deemed it important to provide initial pool size information to help make the trial estimates more meaningful. For example, without pool size information, it was possible that people might base their estimated trials on varying assumptions about the likely pool size, thus introducing unnecessary noise into the estimates and thereby weakening the experimental manipulation.

Table 2
Warning and rebound effects as a function of condition: Studies 2 and 3.

Condition	Initial warning effect	Initial rebound effect	Second warning effect	Second rebound effect
Study 2				
Overall	.001	.001	.909	.080
Warning				
ST	.001	.001	.649	.003
LT	.001	.040	.623	.988
SVO				
Proselfs	.002	.016	.892	.810
Prosocials	.001	.001	.685	.036
Study 3				
Overall	.001	.007	.006	.001
CFC × anchor				
L_{CFC}, L_A	.142	.466	.021	.066
L_{CFC}, H_A	.001	.003	.883	.425
H_{CFC}, L_A	.001	.010	.042	.001
H_{CFC}, H_A	.040	.369	.236	.026

Note. Values shown are *p*-values for within-participant comparisons. Initial warning effect = block 3 vs. block 4; initial rebound effect = block 4 vs. block 5; second warning effect = block 5 vs. block 6; second rebound effect = block 6 vs. block 7. L_A = low anchor; L_H = high anchor.

4.1.3. Trial anchor manipulation

Next, participants received a basic introduction to the resource dilemma game, and were then randomly assigned to one of two trial anchoring conditions. The procedure used to manipulate anchoring and adjustment was modeled on past research (e.g., Tversky & Kahneman, 1974; Wilson, Houston, Etling, & Brekke, 1996). Before making their estimates, participants in the *low trial anchor condition* were asked, "Do you think this game will last 2 trials?" Those in the *high trial anchor condition* were asked, "Do you think this game will last 200 trials?" Most participants in both conditions responded "no" to their respective question. As a manipulation check, after making their binary yes/no response, participants were asked to estimate how many trials they thought the resource would last.

4.1.4. Resource dilemma game

Next, participants proceeded to play a 5-person, 22 trial resource dilemma game. To make the earlier trial estimates make more sense, all participants were told that the resource initially consisted of 600 points. As before, participants were told they could harvest between 0 and 20 points on each trial, and that the resource, if not completely depleted, would regenerate at the end of each trial by adding back into the pool a certain percentage of the remaining points. And, as before, after trials 12 and 16, all participants received a warning that the resource was dangerously close to being depleted (the short-term warning from Study 1).

4.2. Results

4.2.1. Manipulation check

The trial anchoring manipulation had the intended effect: participants in the high anchor condition estimated that the pool would last longer ($M = 53.37$ trials) than participants in the low anchor condition ($M = 5.57$ trials), $t\ (86) = 2.12$, $p < .05$. Trial estimates were not effected by SVO ($p = .57$) or CFC ($p = .44$).

4.2.2. Global analysis

Prior to analysis, participants were classified as low vs. high CFCs on the basis of a median split and points harvested were collapsed into 7 trial blocks. Harvesting on the 7 trial blocks were then analyzed in a 2 (Trial Anchor: low vs. high) × 2 (CFC) × 2 (SVO) × 7 (Trial Block) mixed-model ANOVA with repeated measures on the last factor. Results revealed three main effects. First, there was a marginally significant main effect for trial anchor, $F\ (1, 83) = 3.04$, $p = .09$, $\eta^2 = .04$, with participants in the high anchor condition harvesting more points ($M = 11.39$, SD = 3.86) than those in the low anchor condition ($M = 10.24$, SD = 4.55). Second, there was a marginally significant main effect for SVO, $F\ (1, 83) = 3.56$, $p = .06$, $\eta^2 = .04$, with proselfs harvesting more points ($M = 12.02$, SD = 4.87) than prosocials ($M = 10.38$, SD = 4.00). Third, there was a significant main effect for trial block, $F\ (6, 78) = 8.15$, $p < .001$, $\eta^2 = .38$. As shown in Fig. 7, there was a large drop in harvests following the first warning (on trial block 4), a small rebound effect (on block 5), and a smaller reduction in harvests in response to the second warning (block 6), with a larger rebound on block 7. These results suggest that participants' failure to respond to the second warning in Study 2 (see Fig. 4) was likely due to fear of being a sucker (i.e., reducing harvests in response to the second warning, when feedback indicated that others had not significantly reduced their harvests in response to the first warning).

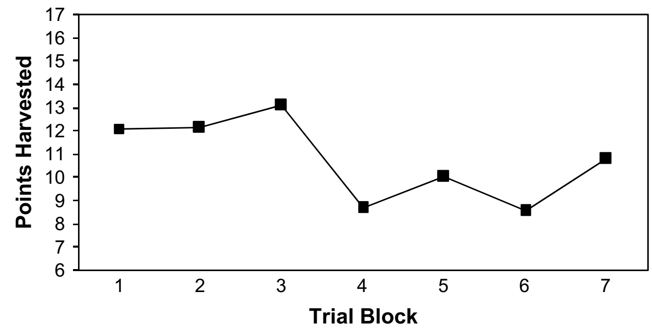

Fig. 7. Points harvested as a function of trial block (Study 3).

In addition to these main effects, results revealed a significant 3-way interaction between trial block, trial anchor, and CFC, $F\ (6, 78) = 2.58$, $p = .03$, $\eta^2 = .17$. Means associated with this interaction are shown in Fig. 8. To follow up this significant interaction, separate 2 (Trial Anchor) × 2 (SVO) × 7 (Trial Block) ANOVAs with repeated measures on the last factor were performed within each CFC group. Within the low CFC group, there was a significant Trial Anchor × Block interaction, $F\,(6, 30) = 2.66$, $p = .04$, $\eta^2 = .35$. As can be seen, the nature of this interaction was such that low CFCs in the low anchor condition reduced their harvests in response to both the first and second warning, but showed a rebound in the last block of trials. By contrast, low CFCs in the high trial anchor condition showed a reduction in harvests in response to the first warning, but showed no response to the second warning. This differential pattern of responses in the two trial anchor conditions contrasts with the pattern in the high CFC group. Within the high CFC condition, the Trial Anchor × Block interaction was not significant ($p = .63$), indicating that high CFCs responded to both the first and second warning in the same way, regardless of anchor condition.

4.2.3. Trend analysis

The trend analysis revealed a significant linear trend, $F\ (1, 83) = 19.94$, $p < .0001$, a significant quadratic trend, $F\ (1, 83) = 7.54$, $p < .01$, and a significant cubic trend for the trial block variable, $F\ (1, 83) = 36.71$, $p < .0001$.[6]

[6] Results also revealed a fifth order trend on the trial block variable ($p < .05$), and a CFC × Anchoring Condition × Trial Block interaction on the fourth level trend ($p < .001$).

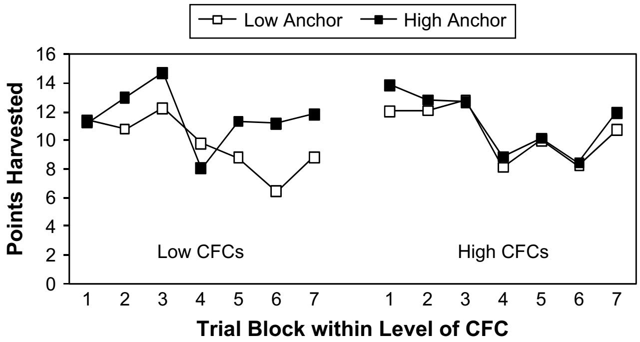

Fig. 8. Points harvested as a function of trial block, consideration of future consequences, and trial anchor condition (Study 3).

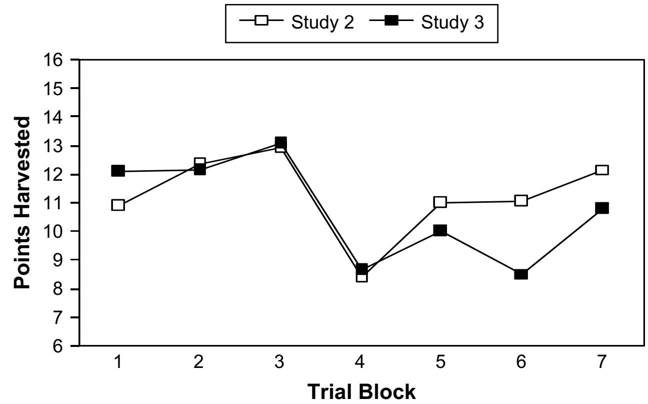

Fig. 9. Points harvested as a function of trial block and study.

4.2.4. Post hoc comparisons

The bottom of Table 2 summarizes the initial and second warning and rebound effects. In line with Study 2, overall, there was a significant initial rebound and warning effect. In contrast to Study 2, however, there was also a significant (second) warning and rebound effect. Also shown in Table 2 are the warning and rebound effects broken down by level of CFC and anchoring condition. As can be seen, low CFCs in the low anchor condition showed only a significant reduction in harvesting in response to the second warning. Low CFCs in the high anchor condition, by comparison, showed an initial warning and rebound effect, but no other effects. High CFCs in the low anchor condition showed significant initial and subsequent warning and rebound effects. Finally, high CFCs in the high anchor condition showed an initial warning effect and a subsequent rebound effect.[7]

4.2.5. Comparison of Studies 2 and 3

To evaluate whether the trial block effect differed between Study 2 and Study 3, we conducted a 2 (Study: 2 vs. 3) × 7 (Trial Block) mixed-model ANOVA with repeated measures on the last factor. This analysis revealed a significant block effect, F (6, 193) = 18.22, $p < .0001$, $\eta^2 = .36$, and a significant Study × Block interaction, F (6, 193) = 3.50, $p < .005$, $\eta^2 = .10$. For comparative purposes, the means are plotted in Fig. 9. As can be seen, the primary difference in the two profiles occurs in response to the second warning (block 6), where participants in Study 2 did not respond to the warning whereas participants in Study 3 did reduce their harvests in response to the second warning, a finding we return to in the discussion.

4.3. Discussion

The present study supported several additional hypotheses and provided insight into participants' failure to respond to the second warning in Study 2. Prosocials again harvested less than proselfs, those in a low anchor condition harvested less than those in a high anchor condition, and the initial warning was more effective than the subsequent warning at reducing harvests (H_2), though in Study 3, the second warning was effective at reducing harvests, in contrast our findings in Study 2. Of course, because response to the second warning was much smaller than response to the first warning, these studies leave open a number of interesting directions for future research on why people seem to be less responsive to subsequent warnings.

5. General discussion

The livelihood of many natural resources depends on people's willingness to reduce consumption when the resource is threatened. As most of the public does not have specific knowledge about the state of natural resources, the public must rely on experts to warn them if the resource is threatened. In the current studies, we investigated how decision makers would react to repeated warnings about a depleting resource about which they had little (Study 3) to no knowledge (Studies 1 and 2). In line with our expectations, initial warnings were more effective than subsequent warnings, high variability in others' harvests led to higher harvesting, proselfs harvested more than prosocials, and people led to believe a resource would last a long time harvested more than those led to believe the resource would last a short time.

In addition to these main effects, we were especially interested in how these person and situation factors would moderate the effectiveness of warnings. Consistent with our interaction hypotheses, warnings were more effective when the variability in others' harvests was small, when the warning emphasized short-term as opposed to long-term consequences, and among those with a prosocial value orientation (H_5; in Study 2, but not Study 1). Contrary to our hypotheses, those low in CFC were actually more responsive to an initial warning than high CFCs. However, in our last study, we found a three-way interaction between trial block, CFC, and trial anchor. This interaction (Fig. 8) suggested that high CFCs responded to both warnings, regardless of anchor condition, whereas low CFCs responded to the second warning only when they had been led to believe the resource would last for a short time; low CFCs in the high anchor condition showed no response to the second warning.

On the whole, the present results help replicate and extend work on social dilemmas and suggest several avenues for future research. In considering the theoretical and practical implications of these findings, it is important to keep in mind, however, that in two of the three studies, decision makers were provided with no information about the size of the resource. As such, the generalizability of these findings to previous social dilemma paradigms (which typically do provide information about the resource size) and the real world (where decision makers have some amount of information about the size of the resource) remains an open question. The present results should therefore be seen as a preliminary step toward understanding how people respond to warnings in resource dilemmas characterized by uncertainty.

[7] An inspection of Fig. 8 would seem to indicate that high CFCs in the high anchor condition should show a significant second warning effect, as they did in the low anchor condition. While harvests did drop among this group, the reduction was not significant. A closer inspection revealed that the standard error associated with this second warning difference score (block 5 vs. block 6) was larger than the standard error within the low anchor condition.

5.1. Warnings

To date, there has been very little direct work examining how warnings about a depleting resource impact harvesting behavior in a commons dilemma. In one recent exception, Vasi and Macy (2003) found that people responded to crisis messages about a depleting resource, but only if given feedback that encouraged them to feel that their reductions in harvesting mattered. The present studies took a different approach to the problem by examining how responsiveness to warnings might change over time and as a function of several person (SVO and CFC) and situation variables (harvesting variability, short-term vs. long-term nature of the warning, and anticipated duration of the resource). Given that warnings interacted with many of these variables, it might be easy to overlook several more basic findings emerging from this work. In particular, while people reduced their harvests in response to the first warning, harvesting tended to rebound in the subsequent trials, and warnings became less effective over time, even when feedback about others' (non-responsiveness) had been removed (Study 3). We believe this is a potentially important finding because it highlights the difficulty of maintaining reduced consumption over time. There could be a number of reasons why people were less responsive to the second warning. First, because no crisis immediately followed the first warning, people may have doubted the validity of the second warning, just as people eventually ignored the boy who cried wolf. Second, because they received no feedback about the effectiveness of their reduced harvests, it is possible that people did not believe further reductions would be helpful. Third, it is possible that people felt that they had sacrificed enough and had already bumped up against a lower bound on a reasonable harvest level (approximately 8 out of 20 points possible). It is also possible that all of these explanations can, in combination, help to explain the reduced effectiveness of the second warning. What is clear, however, is that subsequent warnings *are* less effective. The primary question for future research will be to understand why this is so.

5.2. Moderators of warnings' effectiveness

It is also clear that the effectiveness of warnings depends on the person and the situation. In Study 1, low CFCs were, counterintuitively, more responsive to the single warning, whereas in Study 2, prosocials were more responsive to the first of two warnings. While the former was not expected, it may make sense in retrospect, as the warning used in Study 1 emphasized a potentially immediate crisis, and low CFCs are theoretically more responsive to immediate outcomes. That low CFCs were more responsive than high CFCs is also consistent with the finding from Study 2 that short-term warnings were more effective than long-term warnings.

The finding that prosocials harvested less, on average (in Studies 1 and 3), and were more responsive to warnings than proselfs (in Study 2) also makes sense, and is in line with previous findings that prosocials harvest less on average and are more willing to reduce consumption when it is apparent that a common resource is being threatened (Kramer et al., 1986; Parks, 1994; Roch & Samuelson, 1997). That said, it is important to acknowledge that findings for SVO varied from study to study, and two out of the three studies showed that prosocials and proselfs responded similarly to the warnings. Based on past research, we expected to find that prosocials would be more responsive to the warnings than proselfs, but this only occurred in Study 2. A close inspection of our resource dilemma paradigm may help explain why we failed to replicate previous findings. In previous resource dilemma studies which have shown differences between prosocials and proselfs, participants received feedback that the resource was becoming rapidly depleted over a series of trials (e.g., Kramer et al., 1986; Parks, 1994; Roch & Samuelson, 1997). By contrast, in our studies, participants received no feedback indicating that the resource was rapidly becoming depleted until the critical trials on which the warnings were delivered. Thus, it is possible that spot warnings with no additional feedback were insufficient to motivate sustained conservation among prosocials. More generally, this suggests that differences between prosocials and proselfs are most likely to emerge when the collective consequences of over-consumption are clear and consistent. In fact, this line of reasoning is consistent with Kramer et al.'s findings that prosocials and proselfs only differed when they received feedback that the resource was becoming rapidly depleted. When feedback indicated that the resource was being used at a sustainable rate, prosocials and proselfs did not differ in their harvesting behavior. While we do not wish to oversell a null result, the present studies do seem to reiterate that prosocials may be no more likely than proselfs to conserve if they are unaware that the common resource is becoming rapidly depleted.

Warnings also interacted with features of the situation. One of the more important findings was that people harvested less on average, and were more responsive to warnings, when the variability of others' harvests was low. These findings are consistent with past research on the role of social uncertainty in resource dilemmas (e.g., Jorgenson & Papciak, 1981; Messick et al., 1983) and may hold important practical implications as well. Specifically, if experts hope to gain compliance with warnings, our findings suggest it will be important to find ways to convince people that there is little variability in others' use of resources and that others have reduced their harvests in response to the warning (so as to avoid the sucker's payoff).

Our third study also suggests that people use heuristics to guide their responsiveness to warnings under conditions of uncertainty (cf. Biel & Gärling, 1995; Roch et al., 2000; Van Dijk et al., 1999). While previous studies have demonstrated the importance of heuristics, few studies have examined how the anchoring and adjustment heuristic impacts decision making in resource dilemmas. In one exception, Roch et al. (2000) found that decision makers sharing access to a common resource anchor on an equal division heuristic, and subsequently adjust their requests based on features of the situation. In our study, we provided decision makers with an arbitrarily low or high anchor about the average number of trials the resource might last, and found that this anchor impacted consumption and responses to the warnings.[8] As recent research has found that even the subliminal presentation of a number provides an anchor from which people adjust to make estimates (Mussweiler & Englich, 2005), the presentation of other numbers in the script of the experiment (e.g. the range of points that each participant could harvest on each trial) may also potentially serve as anchors for harvesting decisions. In fact, in all three studies, participants' average harvest on the first trial block was around 11 points (near the midpoint of possible harvests of 10 points). This suggests that participants may apply a heuristic in line with the logic of appropriateness (similar to the equal division heuristic) of harvesting near the midpoint of possible harvests (Weber, Kopelman, & Messick, 2004). Because we did not manipulate the range of possible harvests, we were not able to investigate this further in the

[8] An anonymous reviewer suggested that the low anchor may have served as an initial warning about the longevity of the resource. It is difficult to determine whether this occurred. On the one hand, in line with this reasoning, those in the low anchor condition did tend to harvest fewer points overall. On the other hand, if participants had interpreted the low anchor as an initial warning, it seems we should have found an effect of the anchor condition on harvests within the initial trial blocks, which we did not. In sum, it is unclear whether the low anchor served as an initial warning. However, given its promising practical implications, future research more directly exploring decision makers' interpretation of the low anchor is encouraged.

present study. Real-world resource dilemmas (e.g. water restrictions) sometimes involve boundaries on the amount of the resource that one can take at a given time. As such, this could be one interesting avenue for future research.

Our findings with regard to resource longevity anchors suggest that if people are led to believe that a resource will last a long time, they consume more and are less sensitive to repeated warnings (if they are also low in CFC; Fig. 8). These findings raise several questions for future research. For instance, do these same anchoring and adjustment processes occur in real-world resource dilemmas, and if so, what features of the situation trigger people to anchor on low vs. high values, either for the duration of a resource, the size of a resource, or both? On a related note, how can persuasive messages trigger low anchors and thereby encourage greater resource conservation? Based on our findings, we believe answers to these questions could help improve the effectiveness of warnings that attempt to encourage conservation of natural resources.

5.3. Limitations and future directions

Before closing, it is important to acknowledge several limitations in the present study. First, findings for SVO and CFC were not completely consistent across the three studies, most notably the interactions between these dispositional variables and the warning manipulation. It is not clear why this occurred, but it is possible that slight variations in the experiments, carried out in different labs and with different researcher assistants, may have contributed noise that masked these more subtle interactions. It is also possible that the relatively low numbers of proselfs contributed to low statistical power, and the warnings were so strong that they overrode the impact of personality (e.g., de Kwaadsteniet et al., 2006; Roch & Samuelson, 1997; Snyder & Ickes, 1985). Future research is thus clearly necessary to determine whether these findings are replicable. Second, there are several possible interpretations for why people responded to the second warning in Study 3, but not in Study 2. By eliminating feedback about others' harvests in Study 3, we believe part of the explanation is that people were not responsive to the second warning in Study 2 because they wanted to avoid the sucker's payoff. However, we recognize that several additional explanations may also help to explain people's lower responsiveness to subsequent warnings, and have already outlined several directions for future research along these lines. What is clear is that when repeated warnings about diminishing resources are necessary, experts face an uphill battle in their effort to encourage sustained resource conservation. Future research aimed at better understanding the precise mechanisms for reduced responsiveness over time will clearly move us in the direction of solving challenging resource dilemmas in the real world. Finally, by limiting our focus to experimentally created resource dilemmas with a maximum of 22 trials, we have only begun to scratch the surface of how repeated warnings unfold over time in the real world (cf. Jager, Janssen, & Vlek, 2002; Mosler & Brucks, 2003). Future studies should therefore make an effort to extend these findings by increasing the period of time over which decision makers must manage a common resource, and by attempting to replicate these findings in more applied settings.

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Appendix. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jenvp.2008.10.003.

References

Biel, A., & Gärling, T. (1995). The role of uncertainty in resource dilemmas. *Journal of Environmental Psychology, 15*, 221–233.
Budescu, D. V., Rapoport, A., & Suleiman, R. (1990). Resource dilemmas with environmental uncertainty and asymmetric players. *European Journal of Social Psychology, 20*, 475–487.
Budescu, D. V., Suleiman, R., & Rapoport, A. (1995). Positional order and group size effects in resource dilemmas with uncertain resources. *Organizational Behavior & Human Decision Processes, 61*, 225–238.
Gustafsson, M., Biel, A., & Gärling, T. (1999). Overharvesting of resources of unknown size. *Acta Psychologica, 103*, 47–64.
Hendrickx, L., Poortinga, W., & van der Kooij, R. (2001). Temporal factors in resource dilemmas. *Acta Psychologica, 108*, 137–154.
Hine, D. W., & Gifford, R. (1996). Individual restraint and group efficiency in commons dilemmas: the effects of two types of environmental uncertainty. *Journal of Applied Social Psychology, 26*, 993–1009.
Jager, W., Janssen, M. A., & Vlek, C. A. J. (2002). How uncertainty stimulates overharvesting in a resource dilemma: three process explanations. *Journal of Environmental Psychology, 22*, 247–263.
Joireman, J. (2005). Environmental problems as social dilemmas: the temporal dimension. In A. Strathman, & J. Joireman (Eds.), *Understanding behavior in the context of time: Theory, research, and application* (pp. 289–304). Mahwah, NJ: Lawrence Erlbaum.
Joireman, J., Van Lange, P. A. M., & Van Vugt, M. (2004). Who cares about the environmental impact of cars? Those with an eye toward the future. *Environment and Behavior, 36*, 187–206.
Jorgenson, D. O., & Papciak, A. S. (1981). The effects of communication, resource feedback, and identifiability on behavior in a simulated commons. *Journal of Experimental Social Psychology, 17*, 373–385.
Komorita, S. S., & Parks, C. D. (1994). *Social dilemmas*. Dubuque, IA: Brown & Benchmark Publishers.
Kopelman, S., Weber, J. M., & Messick, D. M. (2002). Factors influencing cooperation in commons dilemmas: a review of experimental psychological research. In E. Ostrom (Ed.), *The drama of the commons* (pp. 113–156). Washington, DC: National Academies Press.
Kortenkamp, K. V., & Moore, C. F. (2006). Time, uncertainty, and individual differences in decisions to cooperate in resource dilemmas. *Personality and Social Psychology Bulletin, 32*, 603–615.
Kramer, R. M., McClintock, C. G., & Messick, D. M. (1986). Social values and cooperative response to a simulated resource conservation crisis. *Journal of Personality, 54*, 576–592.
Kuhlman, D. M., & Marshello, A. F. J. (1975). Individual differences in game motivation as moderators of preprogrammed strategic effects in prisoner's dilemma. *Journal of Personality and Social Psychology, 32*, 922–931.
de Kwaadsteniet, E., van Dijk, E., Wit, A., & de Cremer, D. (2006). Social dilemmas as strong versus weak situations: social value orientations and tacit coordination under resource size uncertainty. *Journal of Experimental Social Psychology, 42*, 509–516.
Mannix, E. A. (1991). Resource dilemmas and discount rates in decision making groups. *Journal of Experimental Social Psychology, 27*, 379–391.
Messick, D. M., & Brewer, M. B. (1983). Solving social dilemmas: a review. In L. Wheeler, & P. Shaver (Eds.), *Review of personality and social psychology, Vol. 4* (pp. 11–44). Beverly Hills, CA: Sage.
Messick, D. M., & McClintock, C. G. (1968). Motivational basis of choice in experimental games. *Journal of Experimental Social Psychology, 4*, 1–25.
Messick, D. M., Wilke, H., Brewer, M. B., Kramer, R. M., Zemke, P. E., & Lui, L. (1983). Individual adaptations and structural change as solutions to social dilemmas. *Journal of Personality and Social Psychology, 44*, 294–309.
Mosler, H.-J., & Brucks, W. M. (2003). Integrating commons dilemma findings in a general dynamic model of cooperative behavior in resource crises. *European Journal of Social Psychology, 33*, 119–133.
Mussweiler, T., & Englich, B. (2005). Subliminal anchoring: judgmental consequences and underlying mechanisms. *Organizational Behavior and Human Decision Processes, 98*, 133–143.
Parks, C. D. (1994). The predictive ability of social values in resource dilemmas and public goods games. *Personality and Social Psychology Bulletin, 20*, 431–438.
Roch, S. G., Lane, J. A. S., Samuelson, C. D., Allison, S. T., & Dent, J. L. (2000). Cognitive load and the equality heuristic: a two-stage model of resource overconsumption in small groups. *Organizational Behavior and Human Decision Processes, 83*, 185–212.
Roch, S. G., & Samuelson, C. D. (1997). Effects of environmental uncertainty and social value orientation in resource dilemmas. *Organizational Behavior and Human Decision Processes, 70*, 221–235.
Samuelson, C. D., Messick, D. M., Rutte, C. G., & Wilke, H. (1984). Individual and structural solutions to resource dilemmas in two cultures. *Journal of Personality and Social Psychology, 47*, 94–104.
Schroeder, D. A., Jensen, T. D., Reed, A. J., Sullivan, D. K., & Schwab, M. (1983). The actions of others as determinants of behavior in social trap situations. *Journal of Experimental Social Psychology, 19*, 522–539.
Schroeder, D. A., & Johnson, D. E. (1982). Utilization of information in a social-trap situation. *Psychological Reports, 50*, 107–113.
Snyder, M., & Ickes, W. (1985). Personality and social behavior. In G. Lindzey, & E. Aronson (Eds.), *The handbook of social psychology* (pp. 883–947). New York: Random House.
Stern, P. C. (1976). Effects of incentives and education on resource conservation decisions in a simulated commons dilemma. *Journal of Personality and Social Psychology, 34*, 1285–1292.

Stern, P. C. (1992). Psychological dimensions of global environmental change. *Annual Review of Psychology, 43*, 269–302.

Strathman, A., Gleicher, F., Boninger, D. S., & Edwards, C. S. (1994). The consideration of future consequences: weighing immediate and distant outcomes of behavior. *Journal of Personality and Social Psychology, 66*, 742–752.

Thompson, S. C., & Stoutemyer, K. (1991). Water use as a commons dilemma: the effects of education that focuses on long-term consequences and individual action. *Environment and Behavior, 23*, 314–333.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: heuristics and biases. *Science, 185*, 1124–1131.

Van Dijk, E., Wilke, H., Wilke, M., & Metman, L. (1999). What information do we use in social dilemmas? Environmental uncertainty and the employment of coordination rules. *Journal of Experimental Social Psychology, 35*, 109–135.

Van Dijk, E., Wit, A., Wilke, H. A. M., & Budescu, D. V. (2004). What we know (and don't know) about the effects of uncertainty on behavior in social dilemmas. In R. Suleiman, D. V. Budescu, I. Fisher, & D. M. Messick (Eds.), *Contemporary psychological research on social dilemmas* (pp. 315–331). New York: Cambridge University Press.

Van Lange, P. A. M., Otten, W., De Bruin, E., & Joireman, J. A. (1997). Development of prosocial, individualistic, and competitive orientations: theory and preliminary evidence. *Journal of Personality and Social Psychology, 73*, 733–746.

Vasi, I. B., & Macy, M. (2003). The mobilizer's dilemma: crisis, empowerment and collective action. *Social Forces, 81*, 979–998.

Weber, J. M., Kopelman, S., & Messick, D. M. (2004). A conceptual review of decision making in social dilemmas: applying a logic of appropriateness. *Personality and Social Psychology Review, 8*, 281–307.

Wilke, H. A. M., & Braspenning, J. (1989). Reciprocity: choice shift in a social trap. *European Journal of Social Psychology, 19*, 317–326.

Wilson, T. D., Houston, C. E., Etling, K. M., & Brekke, N. (1996). A new look at anchoring effects: basic anchoring and its antecedents. *Journal of Experimental Psychology: General, 125*, 387–402.