Uncertainty in social dilemmas

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Does overuse induce anger?

Chapter 5
Emotional Reactions after Overuse[17]

Almost forty years ago, Garrett Hardin (1968) wrote a famous and influential article named "The Tragedy of the Commons". In this article, Hardin addressed the issue of how people deal with scarce common resources. As an example, he described how a group of herdsmen have access to a common pasture. Each herdsman can decide how many animals he keeps on this pasture. It is in each herdsman's personal interest to add more and more animals to his herd. However, if all herdsmen decide to do so, the pasture becomes overgrazed, which is detrimental to all herdsmen. According to Hardin (p. 1244), since every herdsman pursues his own best interest, freedom in a commons inevitably "brings ruin to all".

A situation such as the one described by Hardin is generally referred to as a *common resource dilemma*, which is a specific type of *social dilemma*. A real-life example of a common resource dilemma is the problem of electricity blackouts. Such blackouts occur when the electricity grid breaks down because the collective use of electricity is higher than the available supply (see e.g., Ostrom, 1990, for other real-life examples). Since Hardin's theoretical analysis, numerous empirical studies have been conducted to study when overuse occurs and how overuse can be prevented (see Komorita & Parks, 1995; Kopelman, Weber, & Messick, 2002; Weber, Kopelman, & Messick, 2004, for reviews). However, very little research has been conducted to investigate how people respond to their fellow group members *when* such overuse occurs. How do people react to one another when ruin becomes reality? In the present chapter, we investigate this largely unexplored question.

In this chapter, we focus on affective and retributive reactions after overuse. We will argue and show that group members' reactions after overuse are largely determined by uncertainty regarding the environmental characteristics of a social dilemma. We demonstrate that the same negative outcome (i.e., overuse) can lead to different affective and retributive reactions, contingent upon group members' causal attributions of such an outcome, and that these attributions are largely determined by *environmental uncertainty*.

Affective Reactions after Overuse

How do people respond when a social dilemma results in overuse? Of course, it can be expected that such a negative outcome will elicit negative emotions (cf. Barclay, Skarlicki, & Pugh, 2005; Stouten, De Cremer, & Van Dijk, 2005, 2006).

[17] This chapter is based on De Kwaadsteniet, Van Dijk, Wit and De Cremer (in preparation).

However, earlier research has shown that affective reactions to negative outcomes are not only influenced by the value of the outcomes, in the sense that a negative outcome would simply induce a negative emotion, but are also determined by the way in which such outcomes are attributed (Weiner, Russell, & Lerman, 1979; McFarland & Ross, 1982; Van Dijk, Zeelenberg, & Van der Pligt, 1999; Van Dijk & Zeelenberg, 2002). Thus, in order to predict the emotional reactions after overuse, we focus on the causal attributions of such an outcome.

When a social dilemma results in overuse, group members will try to make sense of this situation by trying to find out who is responsible for the negative outcome (cf. De Cremer & Van Dijk, 2002; McFarland, & Ross, 1982; Weiner, 1985). But how do people respond affectively when they do find out who is responsible? Specifically, how do they respond to their fellow group members when they find out that these group members can be blamed for the occurring overuse? Earlier research (e.g., Tavris, 1982) has shown that blaming another person for a negative outcome is associated with outward-focused negative emotions – such as anger and hostility. Consequently, people will show anger towards their fellow group members when they think that these fellow group members have caused the common resource to become depleted. But under which circumstances will people attribute overuse to their fellow group members? In the following, we argue that this depends on the environmental characteristics of the social dilemma.

Environmental Uncertainty and Causal Attributions of Overuse

How overuse is attributed largely depends on the environmental characteristics of the social dilemma. In real life, these environmental characteristics (e.g., the size of the common resource) are often uncertain. For instance, in the blackout example described earlier, most electricity consumers do not know how large the capacity of the electricity grid is. Such environmental uncertainty (Messick, Allison, & Samuelson, 1988) plays a crucial role in how people attribute overuse in social dilemmas (cf. Rutte, Wilke & Messick, 1987), and consequently, how they respond affectively after overuse.

In many experimental studies on common resource dilemmas, participants know with certainty how large the common resource is. For instance, participants may be told that as a group of five people they share a resource of 500 coins. In that case, all group members know with certainty that the social dilemma will result in overuse if the collective harvest exceeds 500 coins. After all, when the group members collectively harvest more coins than available in the common resource, the resource becomes depleted and no-one receives any money. Often, in symmetric common resource dilemmas (i.e., all people have equal access to the resource) group members decide to harvest an equal share from the common resource (e.g., Allison, McQueen, & Schaerfl, 1992; Allison & Messick, 1990; De Cremer, 2003; Rutte et al., 1987; De Kwaadsteniet et

al., 2006; Van Dijk & Wilke, 1993, 1995; Van Dijk, Wilke, Wilke, & Metman, 1999). When all group members do so, the resource is optimally used and the common resource dilemma does not result in overuse. However, when group members violate this rule by harvesting more than their equal share, the common resource is over-harvested. Thus, when the size of the common resource is known and the dilemma results in overuse, it is clear that this failure was caused by the harvesting decisions of the group members. Therefore, under resource size certainty people will attribute overuse to their fellow group members.

However, in order to know how much the group can harvest without jeopardizing the collective interest, group members need specific and exact information about the task environment of the social dilemma (cf. De Kwaadsteniet et al., 2006; Van Dijk et al., 1999). More specifically, to determine how much each group member should harvest according to the equal division rule, group members need to know exactly how large the common resource is. After all, to calculate an equal share, group members need to divide the size of the common resource by the number of group members. Consequently, in contrast to resource size certainty, under resource size *un*certainty it is unclear how much the group members can harvest without jeopardizing the common resource. Thus, under resource size uncertainty group members cannot simply conclude that overuse was caused by their fellow group members.

Based on the above, we expect that people will attribute overuse more to their fellow group members under resource size certainty than under resource size uncertainty. In accordance with this expectation – and based on the attribution-emotion link described earlier – we predict that people will show stronger negative affective reactions towards their fellow group members under resource size certainty than under resource size uncertainty.

Outline of the Present Research

We investigate our line of reasoning in a series of three experimental studies. In Study 5.1, we provide a first test of our ideas by investigating how people respond affectively after overuse under resource size (un)certainty. In Study 5.2, we extend the findings of Study 1 by not only giving people feedback about the outcome of the social dilemma (i.e., overuse), but by also investigating their affective responses to the harvesting decisions of individual group members. Furthermore, in this study we also investigate people's behavioral responses after overuse, namely, their retributive reactions towards fellow group members. Finally, Study 5.3 focuses on the affective and retributive responses to group members by outside observers, who are not members of the (overusing) group since they do not make any harvesting decisions themselves.

Study 5.1: Affective Reactions after Overuse

As a first test of our ideas, in Study 5.1 we investigated how people respond affectively after overuse. We investigated our line of reasoning in a single-trial common resource dilemma paradigm. In this paradigm, a group of people had access to a common resource from which each of them could freely harvest. However, if the total amount harvested by the group would exceed the amount available in the resource, the common resource would become depleted and all group members would receive zero outcomes (cf. Budescu et al., 1990; De Kwaadsteniet et al., 2006; Gustafsson et al., 1999a, 1999b; Rapoport et al., 1992). We presented participants with either a certain or an uncertain common resource from which they could harvest an amount. After the group members had made their harvesting decisions, we presented them with bogus feedback about the outcome of the dilemma, namely, that the common resource had become depleted (i.e., overuse). After that, the negative affect and attribution questions were posed.

Hypotheses

We formulated the following hypotheses. First, under resource size certainty we expected stronger negative affective reactions than under uncertainty (Hypothesis 5.1). Second, under resource size certainty we expected group members to attribute overuse more to group members' harvesting behavior than under resource size uncertainty (Hypothesis 5.2). Third, we expected the effect of resource size uncertainty on negative affective reactions to be mediated by causal attributions of overuse to their fellow group members (Hypothesis 5.3).

Method

Participants and Design. Participants were 122 students at Leiden University (35 men and 87 women, *M* age = 21.13 years) who were randomly assigned to either a resource size certainty or a resource size uncertainty condition. The participants received 4 for their participation.

Procedure. The participants were invited to the social-psychological laboratory to participate in a study on "group decision making". Upon arrival they were seated in separate cubicles, each containing a personal computer that was used to give instructions and to register the participants' responses.

The Common Resource Dilemma. Participants read a written description of a common resource dilemma. In this dilemma, a group of five people had access to a common resource from which each group member could freely harvest any number of coins (i.e., their individual harvests). The participants were informed that these coins were each worth € 0.03 (€ 1 is approximately US $ 1.65). If the collective harvest

would be smaller than or equal to the resource size, the harvests would be granted and each group member would earn the amount of money he or she had harvested. If, however, the group's collective harvest would exceed the resource size, all group members would earn zero outcomes (cf. Budescu et al., 1990; De Kwaadsteniet et al., 2006; Gustafsson et al., 1999a, 1999b; Rapoport et al., 1992).

Resource Size Uncertainty. Resource size uncertainty was manipulated by varying the range of the uniform distribution of possible resource sizes (cf. Budescu et al., 1990; Budescu, Suleiman & Rapoport, 1995; Gustafsson et al., 1999a; Rapoport et al., 1992). The midpoint of these ranges was kept constant across the two conditions, i.e., 500. In the *Certainty* condition, the size of the resource was certain, i.e., 500 coins (midpoint = 500, range = 0). In the Uncertainty condition, the participants read that the resource would contain at least 100 and at most 900 coins (midpoint = 500, range = 800). In the *Uncertainty* condition, participants learned that afterwards the exact size of the common resource would be randomly drawn from the uniform distribution by a computer (i.e., participants were told that each possible resource size had an equal chance of being drawn from the range).

After the participants had read the instructions of the common resource dilemma, three practice questions were posed to ensure comprehension of the social dilemma situation. For example, participants were asked how much group members would earn if the total group harvest would exceed the size of the common resource. Ninety-seven percent of all participants answered all three questions correctly. After each question, the correct answer was disclosed and the most important characteristics of the situation were repeated.

Overuse Feedback. After the participants had made their harvesting decisions we included some filler questions. We told them that these questions were posed to give all group members enough time to make their harvesting decisions. Additionally, we told them that meanwhile the computer would calculate whether the common resource had been depleted or not. Filling in these questions took about a minute. Subsequently, the participants learned that all group members had made their harvesting decisions and that the computer had calculated whether the common resource had been depleted. All participants received bogus feedback indicating that the total group harvest was larger than the amount available in the common resource and that therefore no-one would receive any money. In other words, the participants learned that the common resource dilemma had resulted in overuse. Immediately after that, the negative affect questions were posed.

Questions about Negative Affect. We asked participants to indicate on seven-point scales to what extent they experienced six negative affective reactions towards their fellow group members (i.e., angry, frustrated, irritated, indignant, agitated and hostile; 1 = not at all; 7 = very much so). These items showed good internal consistency (Cronbach's α = .92) and were aggregated to form one scale of negative affect with

higher scores denoting stronger negative affective reactions.

Questions about Causal Attributions. Although the main aim of the present study was to investigate to what extent participants attributed overuse to their fellow group members, we also asked them to what extent they attributed this overuse to the uncertainty of the situation. Thus, after participants had received the overuse feedback, we asked them to what extent they thought that the overuse was caused by their fellow group members' choice behavior. To do so, we asked participants two questions: namely (a) to what extent they thought their fellow group members were responsible for the overuse, and (b) to what extent they thought their fellow group members had caused the overuse (1 = not at all; 7 = very much so). These two questions showed good internal consistency (Cronbach's $\alpha = .88$) and were aggregated to form one attribution measure with higher scores denoting stronger attributions to fellow group members. Additionally, we asked participants to what extent they attributed the overuse to the uncertainty of the situation (1 = not at all; 7 = very much so).

Results

Checks. The manipulation of resource size uncertainty was checked by asking participants to indicate how uncertain they were about the size of the resource (1 = not uncertain at all; 7 = very uncertain). An ANOVA on this measure yielded a highly significant main effect of Resource Size Uncertainty, $F(1, 120) = 829.75$, $p < .001$, $\eta^2 = .87$. As expected, resource size uncertainty was higher in the Uncertainty condition ($M = 6.36$) than in the Certainty condition ($M = 1.33$). These results show that we successfully manipulated resource size uncertainty.

The induction of overuse feedback was checked by asking participants whether the feedback they had received indicated that their group's collective harvest had exceeded the size of the resource or not (1 = yes; 2 = no). All participants correctly indicated that their group had exceeded the common resource which shows that our induction of overuse was successful.

Individual Harvests. An ANOVA on participants' individual harvests did not yield a significant effect of Resource Size Uncertainty, $F(1, 120) = .001$, $p = .98$, $\eta^2 < .001$. In the two Resource Size Uncertainty conditions, participants harvested roughly the same number of coins from the common resource (i.e., Uncertainty: $M = 104.36$; $SD = 86.97$; Certainty: $M = 103.98$; $SD = 52.61$).[18]

Negative Affective Reactions. An ANOVA on the aggregated negative affect

[18] Although not relevant to our reasoning, it may be interesting to note that in accordance with earlier research (e.g., Budescu et al., 1990; Gustafsson et al., 1999a, 1999b; Rapoport et al., 1992), we found that the variance of participants' harvests was higher in the uncertainty condition than in the certainty condition. What we did not find, however, was the over-harvesting effect that is usually found under environmental uncertainty. This might be due to the fact that in earlier studies uncertainty was manipulated within participants, whereas in the present chapter it was manipulated between participants.

measure yielded a significant main effect of Resource Size Uncertainty, $F(1, 120) = 4.47$, $p < .05$, $\eta^2 = .04$. In agreement with Hypothesis 5.1, Participants showed less negative affective reactions towards their fellow group members under Uncertainty ($M = 3.17$) than under Certainty ($M = 4.07$). See Table 5.1 for the means involved in this analysis.

Table 5.1. *Negative Affective Reactions towards Fellow Group Members by Resource Size Uncertainty*

	Resource Size Uncertainty	
	No	Yes
Negative affect	4.07[a]	3.17[b]
	(1.68)	(1.64)

Note. Higher scores denote stronger mean affective reactions. Standard deviations are given in parentheses. Means with different superscripts differ significantly ($p < .01$, t-test).

Causal Attributions of Overuse. We asked participants two questions to indicate to what extent they thought the overuse was caused by their fellow group members' harvesting behavior. An ANOVA on the aggregated attribution measure yielded a significant main effect of Resource Size Uncertainty, $F(1, 120) = 13.81$, $p < .001$, $\eta^2 = .10$. In agreement with Hypothesis 5.2, participants attributed the overuse less to their fellow group members under Uncertainty ($M = 4.93$) than under Certainty ($M = 5.91$).[19]

Additionally, we asked participants to indicate to what extent they thought the overuse was caused the uncertainty of the situation. An ANOVA on this measure again yielded a significant main effect of Resource Size Uncertainty, $F(2, 120) = 4.28$, $p < .05$, $\eta^2 = .05$. As expected, participants attributed the overuse more to the situation under Uncertainty ($M = 5.26$) than under Certainty ($M = 4.14$). See Table 5.2 for the means involved in these analyses.

Table 5.2. *Attributions of Overuse by Resource Size Uncertainty and Level of Attribution*

Level of Attribution	Resource Size Uncertainty	
	No	Yes
Fellow group members	5.91[a]	4.93[b]
	(1.47)	(1.24)
Uncertainty of the Situation	4.14[a]	5.26[b]
	(1.96)	(1.42)

Note. Higher scores denote stronger mean attributions. Standard deviations are given in parentheses. For each row, means with different superscripts differ significantly ($p < .05$, t-tests).

[19] It is important to note here that people's attributions may also be influenced by their own harvesting decisions (e.g., whether they have adhered to the equal division rule themselves). We will elaborate on this issue later on in this chapter.

Mediation Analysis. To test whether participants' negative affective reactions could be explained their attributions of the overuse to their fellow group members (see Hypothesis 5.3), we performed a mediation analysis with Resource Size Uncertainty (i.e., No vs. Yes) as the independent variable, affective reactions as the dependent variable and attributions to the choice behavior of fellow group members as the mediator (cf. Baron & Kenny, 1986). We first performed a regression analysis on affective reactions with resource size uncertainty as the predictor. This analysis showed that resource size uncertainty significantly predicted participants' affective reactions, $\beta = -.264$, $p < .01$. Second, we performed a regression analysis on the mediator with resource size uncertainty as the predictor. This analysis showed that resource size uncertainty also significantly predicted participants' attributions to their fellow group members' choice behavior, $\beta = -.290$, $p < .01$. Third, a regression analysis with both resource size uncertainty and the mediator as independent variables showed that the mediator significantly predicted participants' affective reactions, $\beta = .540$, $p < .001$, whereas the effect of resource size uncertainty disappeared and became non-significant when the mediator was included, $\beta = -.090$, $p = .26$. Moreover, a Sobel test showed that the decrease of this latter effect was significant (Sobel test value = -3.27, $p < .01$). Altogether, these regression analyses indicate that the effect of resource size uncertainty on participants' affective reactions was significantly mediated by participants' attributions to their group members' choice behavior, which is fully in line with hypothesis 5.3.[20]

Discussion

The results of Study 5.1 support our first set of hypotheses. Under resource size certainty participants showed stronger negative affective reactions towards their fellow group members than under resource size uncertainty (Hypothesis 5.1). Additionally, under resource size certainty participants attributed the overuse more to their fellow group members than under resource size uncertainty (Hypothesis 5.2). Moreover, the effect of uncertainty on participants' negative affective reactions was mediated by their attributions of the overuse to their fellow group members (Hypothesis 5.3). Additionally, we found that under resource size certainty overuse was attributed less to the situation than under resource size uncertainty.

[20] We also tested whether the effect of uncertainty on affective responses to fellow group members was mediated by participants' attributions of overuse to the uncertainty of the situation. This was not the case. This finding can be explained by the fact that we asked participants about the emotional reactions to their fellow group members and not about their emotional reactions to the situation.

Study 5.2: Reactions to Feedback about Individual Harvests

The results of Study 5.1 provide a first corroboration of our idea that under uncertainty people become less angry after overuse than under certainty. However, in this first study we only gave participants feedback about the *collective outcome* of the social dilemma, namely that the dilemma had resulted in overuse. By doing so, we showed that the same negative outcome (i.e., overuse) can elicit different affective reactions depending on the environmental characteristics of the social dilemma. However, our line of reasoning suggests that people may not only respond differently to the same collective outcome (i.e., collective overuse) under different levels of environmental uncertainty, but also to the same individual harvesting decisions. That is, our reasoning should extend to affective reactions towards individual group members. More specifically, reactions towards an individual making the same harvesting decision may be different depending on whether or not there is uncertainty about the size of the common resource. To investigate this possibility, we performed a second study in which we gave participants bogus feedback about the individual harvesting decisions of their fellow group members (i.e., in addition to feedback that the common resource had been depleted). In this Study, we aimed to investigate how people would respond to their fellow group members when they knew exactly how much these group members had harvested. Would people become less angry under uncertainty (as opposed to certainty) towards a fellow group member who had harvested a relatively large amount? This question was addressed in Study 5.2.

Under resource size certainty group members who harvested relatively large amounts (i.e., high harvesters) have jeopardized the collective interest by not adhering to the equal division rule. It can thus be expected that people will become angry at these high harvesters under resource size certainty. After all, such high harvesters have probably caused the common resource to become depleted. Under resource size uncertainty the story is quite different. Under such uncertainty it cannot be so easily concluded that high harvesters have jeopardized the collective interest. When overuse occurs under uncertainty, it is unclear whether or not these high harvesters have caused the common resource to become depleted. As a consequence, it can be expected that people will become less angry at such high harvesters under resource size uncertainty than under resource size certainty.

To test this line of reasoning, in Study 5.2 we presented participants with the same common resource dilemma as in Study 5.1. Again, we manipulated resource size (un)certainty and provided standard bogus feedback indicating that the common resource had been depleted. However, the difference between these studies was that in Study 5.2 – after giving them the feedback that the resource has been depleted

– we also gave participants bogus feedback about the individual harvesting decisions of two of their fellow group members. One of these two fellow group members had harvested a relatively large number of coins (i.e., 150 coins), whereas the other fellow group member had harvested a more moderate number of coins (i.e., 100 coins).[21] Furthermore, to keep all things equal in both (un)certainty conditions, in the resource size uncertainty condition we also gave participants feedback that the computer had determined that the common resource contained 500 coins. For each of these two fellow group members, we asked the same negative affect and attribution questions as in study 5.1.

Retributive Reactions after overuse

As we mentioned before, in Study 5.2 we also investigated people's behavioral responses after overuse, namely, their retributive reactions towards their fellow group members. Based on earlier research (e.g., Barclay et al., 2005; Stouten et al., 2006), we expected that the effects of overuse might extend to retributions, such as social exclusion and revenge. In other words, when people attribute overuse to a fellow group member, they may also be more inclined to punish this fellow group member for his/her harvesting behavior. To test this expectation, we asked participants a couple of questions about their retributive reactions to their fellow group members.

Hypotheses

Based on the above, we formulated the following hypotheses. First, under resource size certainty we expected participants to show stronger negative affective reactions to a high harvester than under resource size uncertainty (Hypothesis 5.4). Second, under resource size certainty we expected participants to attribute overuse more to the behavior of a high harvester than under resource size uncertainty (Hypothesis 5.5). Third, we expected participants' affective reactions to their fellow group members to be mediated by their causal attributions. The more they would attribute overuse to a specific fellow group member, the angrier they would become at this fellow group member (Hypothesis 5.6). Fourth, we expected participants to show stronger retributive reactions to a high harvester under resource size certainty than under resource size uncertainty (Hypothesis 5.7).

Method

Participants and Design. Participants were 122 students at Leiden University (35 men and 87 women, *M* age = 21.13 years). A 2 (Resource Size Uncertainty: No vs.

[21] Note that under resource size certainty this latter group member (i.e., the group member harvesting 100 coins) has harvested one-fifth of the common resource, and under resource size uncertainty this group member has harvested one-fifth of the midpoint of the range of the uncertain common resource.

Yes) × 2 (Feedback about Individual Harvests: 100 coins vs. 150 coins) factorial design with repeated measures on the latter factor was used. The participants were paid € 4 for their participation.

Procedure. Participants were presented with the same common resource dilemma as in Study 5.1. Again, participants were randomly assigned to one of the two resource size uncertainty conditions (i.e., Certainty vs. Uncertainty) and participants had to fill in the same three practice questions (this time 99 % of all participants answered all three questions correctly). After making their harvesting decisions, participants received bogus feedback about the outcome of the social dilemma, namely that the common resource had become depleted. In this study, we also told the participants in the resource size uncertainty condition that the computer had determined that the common resource had contained 500 coins (i.e., the same resource size as in the resource size certainty condition). After that, they received bogus feedback about the individual harvesting decisions of two of their fellow group members (i.e., Feedback about Individual Harvests). One of these group members had harvested 100 coins, whereas the other one had harvested 150 coins. For each of these two group members, participants responded to a couple of attribution, affect and retribution questions. The two Feedback about Individual Harvests conditions were counter-balanced to check for order effects. Preliminary analyses revealed no significant order effects on any of the dependent variables (all Fs < 1).

Results

Checks. The manipulation of resource size uncertainty was checked by asking participants to indicate how uncertain they were about the size of the resource (1 = not uncertain at all; 7 = very uncertain). An ANOVA on this measure also yielded a highly significant main effect of Resource Size Uncertainty, $F(1, 120) = 354.82$, $p < .001$, $\eta^2 = .75$. As expected, resource size uncertainty was lower in the Certainty condition ($M = 1.69$) than in the Uncertainty condition ($M = 5.84$).

The manipulation of Feedback about Individual Harvests was checked by asking participants how many coins were harvested by the two fellow group members they had received feedback about. Ninety-six % of all participants correctly indicated how many coins each of the two fellow group members had harvested (i.e., 100 and 150 coins, respectively). These results indicate that all our manipulations were successful.

After participants had received feedback about the outcome of the social dilemma, the induction of overuse feedback was checked by asking participants whether the feedback they had received indicated that their group's collective harvest had exceeded the size of the resource or not (1 = yes; 2 = no). All participants correctly indicated that their group had exceeded the common resource.

Individual Harvests. An ANOVA on participants' individual harvests did not

yield a significant effect of Resource Size Uncertainty, $F(1, 120) = 0.02$, $p = .89$. In both Resource Size Uncertainty conditions, participants harvested roughly the same amount of coins from the common resource (i.e., under Certainty [$M = 88.46$; $SD = 54.45$] slightly – though not significantly - less than under Uncertainty [$M = 90.59$; $SD = 108.93$]).

Affective Reactions. In each of the two Feedback about Individual Harvests conditions, we asked participants about the same six negative affective reactions as in Study 5.1 (i.e., angry, frustrated, irritated, indignant, agitated and hostile). Participants were asked to indicate on seven-point scales (1 = not at all; 7 = very much so) to what extent they experienced these affective reactions *towards* the fellow group member they received feedback about. These six items showed good internal consistency (Cronbach's $\alpha = .92$) and were aggregated to form one scale of negative affect with higher scores denoting stronger negative affective reactions. An ANOVA on this measure yielded a significant main effect of Feedback about Individual Harvests, $F(1, 120) = 157.07$, $p < .001$, $\eta^2 = .57$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 120) = 47.84$, $p < .001$, $\eta^2 = .29$.

The main effect of Feedback about Individual Harvests indicated that participants responded more negatively to a fellow group member who had harvested 150 coins ($M = 4.83$) than to a fellow group member who had harvested 100 coins ($M = 2.00$). In accordance with Hypothesis 5.4, the interaction effect showed that under Certainty reactions to a group member who had harvested 150 coins were more negative than under Uncertainty ($M = 3.75$ vs. 2.56, respectively). The affective reactions to a group member who had harvested 100 coins were close to the lower end of the scale, indicating that these reactions were not negative at all. However, under Certainty reactions to a group member who had harvested 100 coins were slightly less negative than under Uncertainty ($M = 1.16$ vs. 1.81, respectively). See Table 5.3 for the means involved in this analysis.

Table 5.3. *Negative Affective Reactions towards a Fellow Group Member by Resource Size Uncertainty and Feedback about Individual Harvests (2 × 2)*

Feedback about Individual Harvests	Resource Size Uncertainty	
	No	Yes
Harvest of 100 coins	1.16^a	1.81^b
	(0.46)	(1.03)
Harvest of 150 coins	3.75^a	2.56^b
	(1.62)	(1.40)

Note. Higher scores denote stronger mean affective reactions. Standard deviations are given in parentheses. For each row, means with different superscripts differ significantly ($p < .001$, t-tests).

Causal Attributions. After participants had received bogus feedback about the harvesting decisions of a fellow group member (i.e., 100 vs. 150 coins), they were asked to what extent they thought the overuse could be attributed to the harvesting decision of this fellow group member. To do so, we posed the same two personal attribution questions as in Study 5.1. Again, these two questions showed good internal consistency (Cronbach's $\alpha = .82$) and were aggregated to form one attribution measure with higher scores denoting stronger attribution. An ANOVA on this measure yielded a significant main effect of Feedback about Individual Harvests, $F(1, 120) = 342.58$, $p < .001$, $\eta^2 = .74$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 120) = 37.48$, $p < .001$, $\eta^2 = .24$.

The main effect of Feedback about Individual Harvests indicated that participants attributed overuse more to a fellow group member who had harvested 150 coins ($M = 4.83$) than to a fellow group member who had harvested 100 coins ($M = 2.00$). In accordance with Hypothesis 5.4, the interaction effect showed that under Certainty participants attributed overuse more to the behavior of a group member who had harvested 150 coins than under Uncertainty ($M = 5.32$ vs. $M = 4.33$, respectively). It should be noted that the responses to a group member who had harvested 100 coins were close to the lower end of the scale. However, under Certainty participants attributed overuse less to the group member who had harvested 100 coins than under Uncertainty ($M = 1.56$ vs. 2.44, respectively). See Table 5.4 for the means involved in this analysis.

Table 5.4. *Attributions of Overuse by Resource Size Uncertainty and Feedback about Individual Harvests (2 × 2)*

Feedback about Individual Harvests	Resource Size Uncertainty	
	No	Yes
Harvest of 100 coins	1.56[a] (0.97)	2.44[b] (1.51)
Harvest of 150 coins	5.32[a] (1.50)	4.33[b] (1.71)

Note. Higher scores denote stronger mean attributions. Standard deviations are given in parentheses. For each row, means with different superscripts differ significantly ($p < .001$, t-tests).

We also asked participants to what extent they thought the overuse was caused by the uncertainty of the situation (1 = not at all; 7 = very much so). A between-participants ANOVA on this measure showed a significant main effect of Resource Size Uncertainty, $F(1, 120) = 8.17$, $p < .01$, $\eta^2 = .06$, indicating that under Uncertainty participants attributed overuse more to the situation than under Certainty ($M = 5.15$ vs. 4.13, respectively).

Mediation Analysis. As in Study 5.1, to test whether participants' affective reactions could be explained by the attributions of overuse to their fellow group members, we performed a mediation analysis. To test this mediation (in a mixed-model

design with one between- and one within-participants factor) we applied a procedure proposed by Judd, Kenny and McClelland (2001). First, we calculated the difference between the affective reactions towards the fellow group member who had harvested 100 coins and the fellow group member who had harvested 150 coins (i.e., DIF-affect). Second, we calculated the difference between the attributions towards the fellow group member who had harvested 100 coins and the fellow group member who had harvested 150 coins (i.e., DIF-attribution). Third, we conducted a mediation analysis with Resource Size Uncertainty as the predictor, DIF-attribution as the mediator, and DIF-affect as the dependent variable.

We first performed a regression analysis on DIF-affect with resource size uncertainty as the predictor. This analysis showed that resource size uncertainty significantly predicted DIF-affect, $\beta = -.534$, $p < .001$, indicating the interaction on affect we also found with the ANOVA mentioned earlier. Second, we performed a regression analysis on the mediator with resource size uncertainty as the predictor. This analysis showed that resource size uncertainty also significantly predicted DIF-attribution, $\beta = -.488$, $p < .001$, indicating the interaction effect on attributions we found earlier. Third, a regression analysis with both resource size uncertainty and the mediator as independent variables showed that the mediator significantly predicted DIF-affect, $\beta = .484$, $p < .001$, whereas the effect of resource size uncertainty on DIF-affect became smaller when the mediator was included, $\beta = -.298$, $p = .001$. Moreover, a Sobel test showed that the decrease of this latter effect was significant (Sobel test value = 4.40, $p < .001$). Altogether, these regression analyses indicate that the effect of resource size uncertainty on DIF-affect was partially (though significantly) mediated by DIF-attribution. In accordance with Hypothesis 5.6, these results show that participants' negative affective reactions can (at least partly) be explained by the attribution of overuse to their fellow group members.

Retributive Reactions. After asking participants about their causal attributions, we asked them four retribution questions towards each of the two individual group members. Participants were asked to what extent they (a) wanted to take revenge on this fellow group member, (b) wanted to sanction this fellow group member, (c) wanted to impose a fine on this fellow group member, and (d) wanted to exclude this fellow group member from the group (1 = not at all; 7 = very much so). These items showed good internal consistency (Cronbach's $\alpha = .85$) and were aggregated to form one retribution scale with higher scores denoting stronger retributive reactions.[22] An ANOVA on this measure yielded a significant main effect of Feedback about Individual Harvests, $F(1, 120) = 151.06$, $p < .001$, $\eta^2 = .56$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 120) = 47.84$, $p < .001$, $\eta^2 = .22$.

[22] We also analyzed these retribution questions separately (also in Study 3). These analyses yielded similar results as the analysis on this aggregate retribution scale.

The main effect of Feedback about Individual Harvests indicated that participants showed stronger retributive reactions to a fellow group member who had harvested 150 coins (*M* = 2.81) than to a fellow group member who had harvested 100 coins (*M* = 1.28). The interaction effect showed that, in accordance with hypothesis 5.7, under Certainty participants showed stronger retributive reactions to a fellow group member who had harvested 150 coins than under Uncertainty (*M* = 3.37 vs. 2.26). Although the retributive reactions to a fellow group member who had harvested 100 coins were very low (i.e., almost 1), under Certainty participants' retributive reactions to a group member who had harvested 100 coins were even lower than under Uncertainty (*M* = 1.13 vs. 1.44). See Table 5.5 for the means involved in this analysis.

Table 5.5. *Retributive Reactions towards a Fellow Group Member by Resource Size Uncertainty and Feedback about Individual Harvests (2 × 2)*

Feedback about Individual Harvests	Resource Size Uncertainty	
	No	Yes
Harvest of 100 coins	1.13[a] (0.46)	1.44[b] (0.76)
Harvest of 150 coins	3.75[a] (1.60)	2.56[b] (1.44)

Note. Higher scores denote stronger mean retributive reactions. Standard deviations are given in parentheses. For each row, means with different superscripts differ significantly ($p < .001$, t-tests).

Discussion

The results of Study 5.2 corroborate our second set of hypotheses. Under resource size certainty participants showed stronger negative affective reactions to a high harvester than under resource size uncertainty (Hypothesis 5.4). Additionally, under resource size certainty participants attributed the overuse more to a high harvester than under resource size uncertainty (Hypothesis 5.5). Moreover, the effect of uncertainty on participants' negative affective reactions was mediated by their attributions of the overuse (Hypothesis 5.6). And finally, under resource size certainty participants were more inclined to punish a high harvester than under resource size uncertainty (Hypothesis 5.7). As in Study 5.1, in this study we also found that under resource size certainty overuse was attributed less to the situation than under resource size uncertainty.

Although not our primary focus, it may be interesting to elaborate on participants' reactions to the fellow group member who had harvested 100 coins. As was shown by the data of Study 5.2, the reactions to this fellow group member were very positive in both (un)certainty conditions. Participants were not angry at this fellow group member and they were not inclined to punish this group member for his/her choice behavior. However, looking at the cell means, it should also be noted that

even here, reactions were affected by uncertainty, i.e., the emotional and retributive reactions to this fellow group member were slightly more positive under certainty than under uncertainty. This finding may be explained by the fact that under resource size certainty this fellow group member had adhered perfectly to the equal division rule. Thus, under resource size certainty participants had no reason at all to blame this person for the overuse. After all, this fellow group member had done the right thing (cf. Messick, 1993; Stouten et al., 2005), and if all group members would have done so the common resource would not have become depleted. As a consequence, the affective and retributive responses to this fellow group member were very close to the lower end of the scale. Under uncertainty, by contrast, it was less clear whether harvesting 100 coins was the right thing to do (cf. De Kwaadsteniet et al., 2006). Therefore, the responses to a person who had harvested 100 coins were slightly less positive than under certainty (see Tables 5.3 to 5.5).

Study 5.3: Reactions from an Outside Observer

The results of Study 5.1 and 5.2 support our ideas. In these studies, however, participants own harvesting decisions may have influenced the way in which they responded to their fellow group members. After all, when you have harvested a relatively large amount yourself you may blame yourself more for the overuse, and as a consequence you will attribute the overuse less to your fellow group members. Therefore, it is important to control for participants' own harvesting decisions in investigating their attributions of overuse. One way of doing so is by including participants' individual harvests as a covariate into the ANOVAs on participants' reactions in Study 5.1 and 5.2. Therefore, we conducted all ANOVAs of Study 5.1 and 5.2 with participants' individual harvests as a covariate. Although these analyses showed that there was indeed a negative relation between participants' own harvests and their attributions of overuse (i.e., the lower their own harvests the more they attributed overuse to their fellow group members), including these harvests as a covariate did not alter our pattern of results. This analysis thus indicated that the findings of our first two studies could not be explained by participants' own harvesting decisions.

In order to make an even stronger case, we conducted a third study in which the participants did not have to make harvesting decisions themselves. This third study was identical to Study 5.2, but now participants only observed and judged the harvesting decisions of the group members involved in the social dilemma. In this way, we excluded the possibility that participants' judgments would be influenced by their own harvesting decisions. Moreover, in Study 5.3 we aimed to replicate the findings of Study 5.2 to obtain additional support for Hypotheses 5.4 to 5.7.

Method

Participants and Design. Participants were 50 students at Leiden University (16 men and 34 women, *M* age = 20.00 years). A 2 (Resource Size Uncertainty: No vs. Yes) × 2 (Feedback about Individual Harvests: 100 coins vs. 150 coins) factorial design with repeated measures on the latter factor was used. The participants were paid € 4 for their participation.

Procedure. Participants were presented with the same common resource dilemma as in Studies 1 and 2. Again, participants were randomly assigned to one of the two resource size uncertainty conditions (i.e., Certainty vs. Uncertainty) and participants had to fill in the same three practice questions as in the previous two studies (this time 98 % of all participants answered all three questions correctly). This time the participants did not have to make a harvesting decision themselves, but we told them that it was their task to judge the harvesting decisions of the group members involved in the common resource dilemma. Again, we told the participants that the common resource had become depleted. As in Study 5.2, we also told the participants in the resource size uncertainty condition that the computer had determined that the common resource contained 500 coins (which is the same resource size as in the resource size certainty condition). As in Study 5.2, they received bogus feedback about the individual harvesting decisions of two of the group members (i.e., Feedback about Individual Harvests: 100 vs. 150 coins). For each of these two group members, participants were asked respond to the same affect, attribution and retribution questions as in Study 5.2. The two Feedback about Individual Harvests conditions were counter-balanced to check for order effects. No significant order effects were found (all *F*s < 1).

Results

Checks. The same checks were administered as in Study 5.2. First, an ANOVA on the manipulation check of resource size uncertainty yielded a highly significant main effect of Resource Size Uncertainty, $F(1, 48) = 89.89$, $p < .001$, $\eta^2 = .65$. As expected, uncertainty was lower in the Certainty condition ($M = 1.82$) than in the Uncertainty condition ($M = 5.91$). Second, ninety-five % of all participants correctly indicated how many coins both group members had harvested (i.e., 100 vs. 150 coins, respectively). These results show that both manipulations were successful. Third, all participants correctly indicated that their group had exceeded the common resource.

Affective Reactions. An ANOVA on the aggregated affect measure (Cronbach's $\alpha = .95$) yielded a significant main effect of Feedback about Individual Harvests, $F(1, 48) = 90.69$, $p < .001$, $\eta^2 = .65$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 48) = 24.38$, $p < .001$, $\eta^2 = .34$. The main effect of Feedback about Individual Harvests indicated that participants responded more negatively to a group member who had harvested 150 coins ($M = 3.86$) than to a

group member who had harvested 100 coins (M = 1.86). In accordance with Hypothesis 5.4, the interaction showed that under Certainty reactions to a group member who had harvested 150 coins were *more* negative than under Uncertainty (M = 4.22 vs. 3.40, respectively). As in Study 5.2, the affective reactions to a fellow group member who had harvested 100 coins were not negative at all. However, under Certainty reactions to this group member were *slightly* less negative than under Uncertainty (M = 1.36 vs. 2.49, respectively).

Attributions. An ANOVA on the aggregated attribution measure (Cronbach's α = .92) yielded a significant main effect of Feedback about Individual Harvests, $F(1, 48) = 105.51$, $p < .001$, $\eta^2 = .69$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 48) = 31.36$, $p < .001$, $\eta^2 = .40$. The main effect of Feedback about Individual Harvests indicated that participants attributed overuse more to a group member who had harvested 150 coins (M = 5.21) than to a group member who had harvested 100 coins (M = 2.69). In accordance with Hypothesis 5.5, the interaction effect showed that under Certainty participants attributed overuse *more* to the behavior of a group member who had harvested 150 coins than under Uncertainty (M = 5.33 vs. M = 5.06, respectively). As in Study 5.2, the attributions of overuse to a fellow group member who had harvested 100 coins were very close to the lower end of the scale. However, under Certainty participants attributed overuse slightly *less* to the choice behavior of this group member than under Uncertainty (M = 1.68 vs. 3.98, respectively).

As in Study 5.1 and 5.2, we also asked participants to what extent they thought the overuse was caused by the uncertainty of the situation. A between-participants ANOVA on this measure showed a significant main effect of Resource Size Uncertainty, $F(1, 48) = 12.81$, $p < .05$, $\eta^2 = .12$, indicating that under Uncertainty participants attributed overuse more to the situation than under Certainty (M = 5.59 vs. 4.57, respectively).

Mediation Analysis. In order to test the predicted mediation we applied the same procedure as in Study 5.2. First, we showed that resource size uncertainty significantly predicted DIF-affect, β = -.505, $p < .001$, indicating the interaction on affect we also found with the ANOVA mentioned earlier. Second, we showed that resource size uncertainty also significantly predicted DIF-attribution, β = -.540, $p < .001$, indicating the interaction effect on attributions we found earlier. Third, we showed that the mediator significantly predicted DIF-affect, β = .653, $p < .001$, whereas the effect of resource size uncertainty on DIF-affect became smaller and non-significant when the mediator was included, β = -.152, p = .09 (Sobel test value = 5.93, $p < .001$). In accordance with Hypothesis 5.6, these regression analyses thus indicate that the effect of resource size uncertainty on DIF-affect was fully mediated by DIF-attribution, which implies that participants' negative affective reactions can be explained by the attributions of overuse to their fellow group members.

Retributive Reactions. An ANOVA on the aggregated retribution measure (Cronbach's α = .86) yielded a significant main effect of Feedback about Individual Harvests, $F(1, 48) = 61.25$, $p < .001$, $\eta^2 = .56$, and a significant Resource Size Uncertainty by Feedback about Individual Harvests interaction effect, $F(1, 48) = 11.01$, $p < .01$, $\eta^2 = .19$. The main effect of Feedback about Individual Harvests indicated that participants showed stronger retributive reactions to a group member who had harvested 150 coins (M = 3.40) than to a group member who had harvested 100 coins (M = 1.70). In accordance with Hypothesis 5.7, the interaction effect showed that under Certainty participants showed stronger retributive reactions to a group member who had harvested 150 coins than under Uncertainty (M = 3.63 vs. 3.10, respectively). As in Study 5.2, participants' retributive reactions to a fellow group member who had harvested 100 coins were very low. However, under Certainty participants' retributive reactions to this group were *slightly* lower than under Uncertainty (M = 1.33 vs. 2.17, respectively).

Discussion

In Study 5.3, we fully replicated the findings of Study 5.2. By focusing on the judgments of an outside observer, we again found strong support for Hypotheses 5.4 to 5.7. These findings clearly show that our ideas still hold when the participants do not make harvesting decisions themselves, and that these ideas are also applicable to outside observers. By showing this, we demonstrated how pervasive our effects are. Evidently, people can become angry at high harvesters and are willing to punish these high harvesters *even* when their own outcomes are not at stake. Again, it was shown that these reactions were stronger under certainty than under uncertainty.

General Discussion

The results of our three experimental studies strongly corroborate our hypotheses. Our first study corroborates our first set of hypotheses (i.e., Hypotheses 5.1 to 5.3). We found that under resource size certainty people show stronger negative affective reactions after overuse because they attribute this negative outcome more to their fellow group members' choice behavior than under resource size uncertainty. Moreover, in accordance with our second set of hypotheses (i.e., Hypotheses 5.4 to 5.7), our last two studies showed that under certainty people respond more negatively to high harvesters than under uncertainty. Under resource size certainty people attribute overuse more to such high harvesters, they are angrier at these high harvesters, and they are more inclined to punish these high harvesters for their choice behavior than under resource size uncertainty. In the following, we will address the more general implications of these findings.

Reactions to High Harvesters under Environmental Uncertainty

As Hardin stated (1968, p. 1244), social dilemmas inevitably lead to "ruin to all". In a way, we took Hardin's endpoint as the starting point of our research. We wanted to know how people react when ruin becomes reality. More specifically, we focused on how people responded affectively after overuse. We showed that these reactions were less negative under resource size uncertainty than under resource size certainty. By doing so, we demonstrated that, depending on the environmental characteristics of the social dilemma, the same negative outcome (i.e., overuse) can lead to different affective reactions. Moreover, besides focusing on how people react to the overuse itself (i.e., overuse as an outcome), we also investigated how people responded to the individual harvesting decisions of their fellow group members. In line with our expectations, our results showed that under resource size uncertainty people become less angry at group members who harvest relatively large amounts and that they also show milder retributive reactions to such high harvesters than under resource size certainty. At this point, it may be interesting to relate these findings to suggestions done in other studies on environmental uncertainty.

In earlier papers on environmental uncertainty in social dilemmas (e.g., De Kwaadsteniet et al., 2006; Gustafsson, 1999a, b; Hine & Gifford, 1996; Rapoport et al., 1992), it was repeatedly argued that group members may use such uncertainty to further their own self-interest. For instance, in one of our earlier studies (De Kwaadsteniet et al., 2006), we showed that under resource size uncertainty proselfs (i.e., people with a dispositional preference to further their self-interest) harvested larger amounts than under resource size certainty. We explained this finding by arguing that under resource size uncertainty proselfs could justify relatively high harvests by arguing that they thought there would be more than enough money in the uncertain common resource (also referred to as *egoism-justification*; see Gustafsson et al., 1999a, 1999b). Proselfs seemed to think that under resource size uncertainty they could get away with harvesting such relatively large amounts. However, the question still remained as to whether this was really the case: Can people really get away with high harvests under resource size uncertainty?

The present research provides a tentative answer to this question. Our results show that under resource size uncertainty group members respond more mildly to high harvesters than under resource size certainty. After all, under uncertainty group members cannot simply determine whether high harvesters have caused the common resource to become depleted and therefore they become less angry at these high harvesters than under certainty. These findings suggest that high harvesters can indeed more easily get away with their "greedy" harvesting behavior under resource size uncertainty.

Managing an Uncertain Common Resource

The above line of reasoning also shows the importance of environmental uncertainty for the enforcement of the equal division rule. After all, this rule only prescribes an unequivocal harvest level when there is environmental certainty. In most real-life social dilemmas, however, there is uncertainty about the environmental characteristics of the dilemma. When these characteristics become uncertain – such as the resource size or the group size – people may not be able to determine whether their fellow group members have violated this rule (cf. De Kwaadsteniet et al., 2006). In line with this reasoning, our findings suggest that under such circumstances it is more difficult for group members to enforce the use of this rule (e.g., by means of retributions), even if they have full information about their fellow group members' harvesting decisions.

Thus, when the task environment does not allow for a division rule to prescribe an unequivocal amount to harvest, group members must find another way to efficiently manage the common resource. According to Ostrom (1990), group members (referred to as "appropriators") must then define the boundaries of the common resource themselves. In other words, based on the "local" conditions of the common resource, they must agree on how much each group member is allowed to harvest from the common resource. However, in many social dilemmas the group members cannot communicate with one another and therefore it is impossible for them to agree on an "appropriate" amount to harvest. In the absence of communication, resource size uncertainty may thus hamper the enforcement of division rules, which jeopardizes the collective interest by increasing the chance that the common resource becomes depleted.

Earlier Research on Causal Attributions and Environmental Uncertainty

At this point, it may be interesting to relate the findings of the present research to findings from a study by Rutte, Wilke and Messick (1987). Rutte et al. investigated attributions of scarcity and abundance in a common resource dilemma. In contrast to our research – in which we used a simultaneous protocol of play – Rutte et al. used a sequential protocol of play (i.e., harvesting decisions were made sequentially). Participants were told that as a member of a six person group, they themselves were the fifth member to harvest an amount from the common resource. In this experiment, Rutte et al. also manipulated resource size uncertainty asymmetrically, i.e., in the uncertainty condition of this experiment only the first four group members were uncertain about the size of the common resource. Scarcity and abundance were manipulated by varying the amount of money left for the last two group members (i.e., group members 5 and 6). In the scarcity condition, there was *less* than an equal share left for each of the last two group members, whereas in the abundance condition there was *more* than an equal share left for each of the last two group members. In accordance with our

findings, Rutte et al. found that in the certainty condition participants indicated that their fellow group members were more responsible for the outcome than in the uncertainty condition.

The above findings – which demonstrate the relation between environmental uncertainty and causal attributions – are in agreement with our line of reasoning (see also Wit, Wilke, & Van Dijk, 1989, on causal attributions of a leader's success or failure under environmental (un)certainty). However, Rutte et al. (1987) did not investigate how participants reacted affectively to fellow group members under scarcity and abundance. As we mentioned earlier, until recently (see Stouten et al., 2005, 2006, for exceptions) very little research has been done on emotions in social dilemmas. However, such emotional reactions can have important behavioral consequences. After all, research has shown that emotions can have a substantial impact on people's decisions. For instance, we argued and showed that anger-related emotions can extend to retributive reactions, such as social exclusion and revenge. Therefore, it is important to not only focus on how people attribute overuse, but to also focus on people's affective and retributive reactions towards fellow group members after such overuse.

We showed that causal attributions of overuse can affect people's affective and retributive reactions to their fellow group members. When group members attribute overuse more to their fellow group members, they become angrier at these fellow group members and they also show stronger retributive reactions to these fellow group members. By showing this, we demonstrated how and when attributions of overuse can be important. After all, attributions of overuse can have serious consequences for the group members this outcome is attributed to.

Conclusions

In the present chapter, we investigated how people deal with the "tragedy of the commons" (Hardin, 1968). Specifically, we focused on people's affective and retributive responses after overuse. By doing so, the present research has generated a number of new insights. First, we demonstrated that resource size uncertainty has a substantial impact on how people respond affectively after overuse. Second, we showed that under resource size uncertainty people attribute such overuse less to their fellow group members than under certainty. Third, we investigated how these attributions affected people's affective and retributive reactions. We showed that under resource size uncertainty people's affective and retributive responses after overuse are less negative than under certainty. Altogether, these findings underline the importance of environmental uncertainty by demonstrating that such uncertainty plays a crucial role in how people respond after overuse in social dilemmas.