The Tragedy of Inner-Individual Dilemmas

Momme von Sydow (momme.von-sydow@psychologie.uni-heidelberg.de
University of Heidelberg, Department of Psychology, Hauptstr. 47-51,
D-69117 Heidelberg, Germany

Abstract

Social dilemmas specify situations in which (local) egoistic utility optimization prevents achieving the (global) common good of a group. Tragically, in such dilemmas local optimization also reduces the payoff for the individual optimizer. Although social dilemmas essentially reflect inter-individual contexts (conflicting interests, moral attitudes, etc.), inner-individual dilemmas apparently share at least some structural aspects with them: individual behavior can concern more conflicting levels of optimization. For example, starting additional academic projects with potentially positive 'payoff' may assume 'more is more'. However, exogenous effects may arise from optimizing local goals; further contributions may incrementally reduce the quality of other contributions and yield 'more is less'. In three experiments we explore a *one-person* investment game about building hotels, reflecting a social dilemma. The payoffs involve different optima for local and global optimization. Results show that people can be influenced by a default-strategy of 'more is more', even if it is irrational.

Keywords: inner-individual dilemmas; social dilemmas; self-regulation; 'less is more'; sustainability; externalities; global vs. local optimization

On Social and Inner-Individual Dilemmas

Hardin (1968) has pointed out the inevitability of a destruction of public resources by 'rationally' acting selfish individuals. This 'tragedy of the commons' refers to self-interested use of the commons, environmental pollution, and the destruction of beaches in Spain by competing hotel-builders. Game theory conceptualizes social dilemmas; for instance, as prisoner dilemmas or public good games. Without changing the payoff structure of these games, the assumed individual (local) optimization will inevitably have to reduce the payoff/utility for all group members. Although such a description seems to share with neo-classical economics some broad idea of individualism, the wide-spread game theoretical description seems to dispense with the neo-classical optimism that assumes that—as by an invisible hand (Adam Smith)—individual optimization ultimately leads to a common good.

Recent decades has also led to a lively discussion of several possible solutions of these perhaps not always inevitable tragedies (e.g., Ostrom et al., 1999). In this period, multi-level approaches in evolutionary biology have cast doubt on the *strict* egoism assumption (Sober & Wilson, 1999; Wilson & Wilson, 2007; cf. von Sydow, 2011); and research in psychology and behavioural economics has eroded an explicit or tacit egoism assumption and explored ways people may sometimes resolve or mitigate social dilemmas (e.g., Fehr & Fischbacher, 2003, 2004). The solution of social dilemmas, however, remains a theoretically and practically challenging topic of research.

Analogous to the normal, two levels of optimization in 'public good games', we investigate here inner-individual, partly analogous dilemmas with potential sacrifice of global optimization by optimizing the number of pursued local goals. Individuals aim to maximize their global utility by achieving several *local* goals, each with a positive payoff. Pursuing an additional local goal with positive utility, however, may sometimes reduce the global payoff by negatively affecting the achievement of other goals. That is, people may sometimes ignore interactions between goals. Thus we are concerned with the issue of disregarded external effects or externalities, not within a group (social dilemmas) but within an individual (individual dilemmas). People may perhaps often follow a 'more-is-more' default strategy/ heuristic, ignoring externalities,even when this affects the successful achievement of other goals so negatively that individually local optimization yields overall negative outcomes.

To illustrate this, we examine an investment game concerned with building hotels. In the domain of *social* dilemmas, unsustainable hotel-development provides examples of 'local optimization beats global optimization'. There are cases—perhaps many—where building hotels may have successively transformed magnificent beaches, first into profitable hotel resorts but then into beaches without tourists but filled aesthetically displeasing hotels. Here *inter*-individual factors loom large: competition, inadequate regulation, questionable moral behaviour, inadequate incentives, and poor co-ordination of group interests. And yet, could not similar dilemmas also occur within a single person?

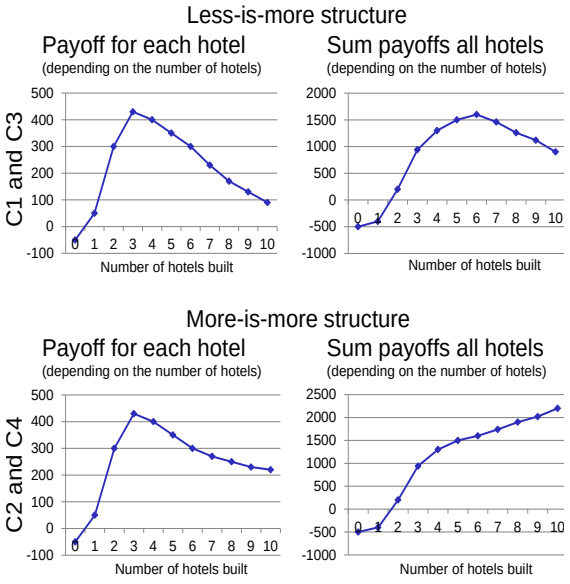

Figure 1: Average experienced payoffs for the more-is-more and the less-is-more payoff conditions.

Tension between Local and Global Optimization in the Experiments

This paper investigates individual dilemmas while set in the context of a social dilemma of hotel-building. The question is: when *one* individual owns the whole beach, will he or she keep building less and less profitable hotels and keep building hotels even when their number renders the overall beach less profitable?—We conducted three experiments, with participants explicitly playing a *one*-person investment game, exploring experience-based decision making where one individual player could build or remove hotels on a beautiful beach of his or her own.

Payoff structures We investigated different interactions of payoff per hotel with the number of hotels built on that beach. Figure 1 shows the average payoffs (we added some random noise to prevent all hotels' having exactly the same payoffs in a given round). On the *local* level (left side slides in Figure 1), the average payoffs shown for a single hotel in both types of payoff conditions were always largest when one owned three hotels. This formalizes the assumption that, on the one hand, the hypothetical target group likes some minimal touristic infrastructure (including, for instance, fellow tourists). On the other hand, it assumes a dislike of hotel-skyscraper cities. Additionally, we assume the beach's owner had to pay basic land tax even when no hotel is built (see the resulting negative value when no hotel is built).

Despite the similar aspects, the two local payoff structures fundamentally differed in their resultant *global* payoff (right side of Figure 1). In the *more-is-more* conditions, the negative external effects of hotel-building on the payoff from other hotels are relatively weak. Although the payoff is half as high with ten hotels as with three, the sum of all costs and gains continues to increase per number of hotels. In contrast, in the *less-is-more* condition, the reduction of payoff for each hotel is even greater when more hotels have been built. Although the profit on a single hotel remains positive even if the beach has ten hotels, the global payoff resulting from all cost and gains for all hotels is now reduced by well over a third (right upper slide of Figure 1).

Predictions for the payoff structures What should one predict for experiments on one-person games with an inner-individual dilemma structure (*less-is-more* condition)? What are the normative correct solutions and do they differ from 'normative' standards in commonly assumed social dilemmas? This is relevant, if we are investigating whether participants succumb to irrational decision-strategies in one-person games in a context reminiscent of social dilemmas.

For *social* dilemmas, the standard interpretation of game theory suggests optimizing locally (the outcome of the individual) at the expense of global optimization (the outcome of others). This may be considered as a "context-blind" "narrow norm" (Gigerenzer, 1996). At least in some contexts, ethical norms may appear more reasonable standards, and, sometimes, even more in accordance with actual behavior (Fehr & Fischbacher, 2004). Thus one option might be to replace a game theoretic account by another norm. Alternatively, one may retain the refined mathematical apparatus of rational choice theory and game theory, since its axioms do not require egoism in a psychological sense. Yet one would have to dismiss the indeed often implicit general egoism assumption predominant in traditional applications of game theory and formalize other preference structures and utility functions accounting for sometimes altruistic (in a way, non-local) optimization (Fehr & Schmidt, 1999; Fehr & Gächter, 2002). It seems that in both cases these normatively most interesting questions cannot be derived aprior from the mathematical core of rational choice theory or game theory.

By contrast, for inner-individual dilemmas, at least in cases where the goals are evaluated on commensurable scales, the normative issue appears clear: people *should* optimize their *overall* utility. In our example it can be rational not to optimize locally the number of hotels built, but one's overall payoff from all one's hotels.

With respect to the two specified payoff structures, we investigate two potential deviations from optimization on the global level, both relating to a focus on the local level. First, the optimum at 3 hotels on the local level (left side of Figure 1, both structures) may influence people to build fewer hotels than is globally optimal (6 in the less-is-more structure; 10 in the more-is-more). We call this a potential 'local optimum strategy'. Second, local optimization may alternatively involve the process of focusing on a positive payoff for each hotel but ignoring existing (even substantive) negative externalities. In a less-is-more condition, participants may apply a 'more-is-more' default strategy, thinking more hotels is good, even though actually building new hotels reduces one's global payoff.

Experiment 1

Design

Experiment 1 has a two (payoff structure: less-is-more vs. more-is-more) by two (information presentation format: local-only vs. local-and-global payoff presentation), within-subjects design. Thus participants were randomly assigned one of four conditions:

- C1: less-is-more pay-off, local-only information;
- C2: more-is-more pay-off, local-only information;
- C3: less-is-more pay-off, local and global information;
- C4: more-is-more pay-off, local and global information.

The factor "payoff structures" and corresponding predictions have been discussed above.

The additional factor *information presentation format* varied the accessibility of information. In both cases all information was in principle available. In the *Local-only* format payoff information for each hotel was available only by clicking on the hotels. Moreover, the global payoff per round, even here, could be calculated by subtracting the previous payoff from the present one (although the experimental procedure did not encourage this). In the *local-and-global* presentation format, one was additionally provided with explicit and salient global payoff information for each round. We thought that people in this situation

might act globally optimally, whereas they would not in the local-only conditions.

Method

Participants 119 students from the University of Göttingen voluntarily took part, in exchange for either course credits or money. We analyze here only the 104 participants who ended the game without being bankrupt. Additionally the players were informed that they could win money in a lottery proportionate to their success in the game (with only one player winning).

Procedure and Material The experiment was a one-person investment game at a computer, in which participants could build and remove hotels.

Participants were first given general rules of the game and the number of rounds of the game. First, one should imagine having bought a beautiful bay along a coast, to which this player has sole entitlement. Participants may build hotels in ten possible areas shown on a map (Figure 2). After clicking on each building-area/hotel, a screen represents the relative expenses and income for the place for the corresponding round. The player's income is generated with reference to the payoff-conditions and the given number of built hotels. The expenses involve only a fixed land tax (−50,000 € per building ground/round). Additionally the overall payoff for the hotel was shown, followed by the action-options available—either building or removing a hotel. Building a hotel was shown to cost 400,000 €; removing a hotel 200 000 € for the materials. (It was also mentioned, here and in the introduction, that at the end of the game participants may liquidate all their hotels into cash, to evaluate their overall success)

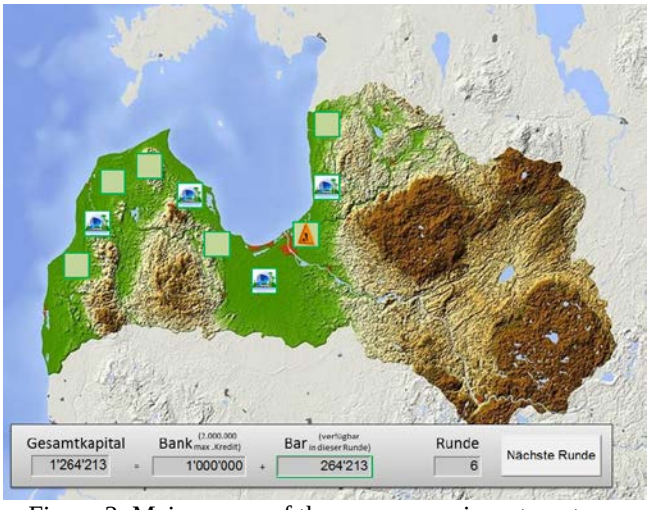

Figure 2: Main screen of the one-person investment game, here with three existing hotels, one hotel to be built, and six other potential hotel-locations.

The explicit goal of the game was for players to increase their (overall) money (after 30 rounds). They started with 1,000,000 € cash and 2,000,000 € credit. Apart from the cash 'account' they had a second account, whose balance could be negative (up to credit of 2,000,000 €) or positive (with money automatically transferred if cash was above 1,200,000, as was shown in a pop-up window). In all conditions, the balance of the accounts and the overall money (cash + bank account) were shown in each round on the main screen (map). The cash was limited to the building of hotels; only up to two hotels per round could be built.

By clicking on a button, participants could decide to proceed to the next round by their own pace. Only then was the building or removing of hotels implemented. The hotel symbol shows a concrete high-rise building with palm. In the global-and-local conditions, an additional pop-up window prominently displayed the overall gain in the round. In the global-and-local conditions players were additionally informed about their overall income in each round.

Results and Discussion

Figure 3 shows the mean number of hotels built in all four conditions and rounds. The results in all conditions show a clear increase of the average number of hotels up to Round 15, followed by slow increase or constancy up to about Round 27, and a final decline in the last rounds.

The final decline relates to the possibility for participants to sell their hotels at the end of the game. As expected, a higher number of participants in the local-only conditions were influenced by the idea of selling hotels in the final round to evaluate their overall success. This may be because people in the local-only conditions were reminded of this option more frequently— it was mentioned also on the local pages.

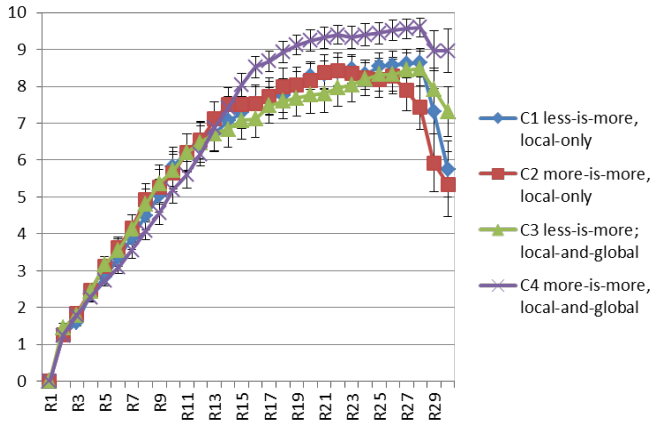

Figure 3: For the four conditions, the mean number of hotels in the 30 rounds of the game.

The main result of Figure 3 relates to the mean number of hotels. Although most people in the less-is-more condition in the later rounds had gone through phases with clearly higher local payoff (since for each round they could build two hotels at most), peoples' decisions led to hotel numbers clearly above the optimal value of six. Moreover, in the local-only conditions there was to no significant difference between less-is-more and more-is-more conditions. Participants in line with our second prediction (a more-is-more

strategy) in this condition seem unable to account for interactions (mutual exogeneities) if provided with information on the local level only. Alternatively, they could have summarized/estimated the local information, or calculated it from differences of the overall money between rounds.

Even in the global-and-local information condition, we obtained almost the same high average numbers of hotels built for the less-is-more condition (C2); even if provided with focal information about the global payoff, and having experienced a phase with notably higher payoffs (earlier rounds), the average number of hotels remained significantly higher than the optimal six hotels. There was no large difference in the mean to the more-is-more condition (normative value of 10).

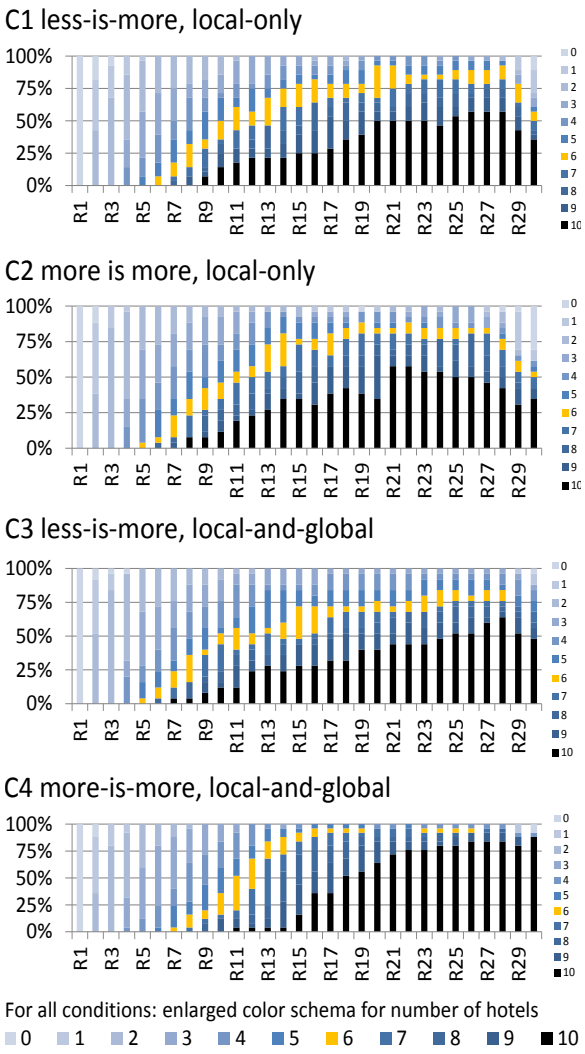

Figure 4: Proportion of participants with a particular number of hotels for the 30 rounds in Experiment 1.

Figure 4 investigates the results on the level of individual results instead of means. The figure shows the proportion of participants with different numbers of hotels in the 30 rounds. Increasingly dark shades of blue represent an increasing number of hotels in a round (0 to 10). Black indicates the maximum of 10 hotels (optimum for the more-is-more conditions); orange, the number of 6 hotels (optimal for the less-is-more conditions).

The results of Figure 4 suggest four points. First, participants do not seem to care for the local optimum of 3 hotels at all. This clearly disconfirms the first considered hypothesis, the 'local optimum strategy' even for the local-only conditions. Second, and in line with the second local strategy, the 'more-is-more' hypothesis, the high average hotel number for all conditions seems explainable to some extent by a high number of maximally allowed buildings (10) in all conditions. Third, the optimal proportion for the less-is-more-condition (6 hotels) is only slightly higher in these conditions than in the more-is-more conditions (with an optimum of 10 hotels). Finally, in the local-and-global conditions there is a considerably higher number of 10-hotels occurrences than in the corresponding more-is-more condition (at least in later rounds).

Overall, the results of this experiment appear inconsistent with the first local strategy discussed (the local optimum strategy)—people appear not to be influenced by the highest payoff on the local level as long as the payoff is positive. However, the results deviate clearly from optimizing and are coherent with the second local strategy (the 'more-is-more' strategy). In line with the latter strategy, at least a part of the participants seems to ignore exogeneities; building more hotels appears positive to them, even if some hotels, each with a positive local payoff, clearly had considerably more detrimental than favorable overall affects.

Experiment 2

Experiment 2 was similar to Experiment 1 and investigated the same payoff conditions. However, it involved 50 rounds instead of 30 to test further the temporal stability of the phenomenon. Second, in Experiment 2 storms were added to the program, which could destroy some hotels. Although previously the successive building of hotels (maximally two each round) forced people to go through the area of substantially higher global payoff (in a less-is-more condition) at least once, this may have prevented them from experiencing jumping between different hotel numbers. Storms led to a sudden reduction in hotel numbers. Thus participants who ultimately built 10 hotels repeatedly experienced that building involved going from higher to lower payoff zones. Third, Experiment 3 only concerns two conditions rather than four. We focused on the local-and-global conditions (with global payoff), which had previously led to the best differentiation between the less-is-more and more-is-more conditions. (We retain the numbering of these conditions as C3 and C4, despite skipping C1 and C2).

Method

Participants 77 participants from the University of Heidelberg voluntarily took part in the experiment and were randomly assigned to one of the two conditions. 66 ended the game without going bankrupt. Participants again

obtained either course credits or money, and they could participate in a lottery (cf. Experiment 1).

Material and procedure Apart from the already cited differences in material and procedure, Experiment 2 was largely identical to Experiment 1. Storms occurring in rounds 25/26 and 38/39 normally destroyed three hotels, but if one only owned 1 to 3 hotels, only 1 hotel was destroyed. Participants got all money back they spend in the destroyed hotel (due to a insurance). Some minor changes were made, such as increasing the divisor for the gained fictive money to determine the price in the lottery (given the larger number of rounds, this kept the incentive more constant).

Results and Discussion

Figure 5 shows the proportion of hotels that had been built in the 50 rounds of Experiment 2.

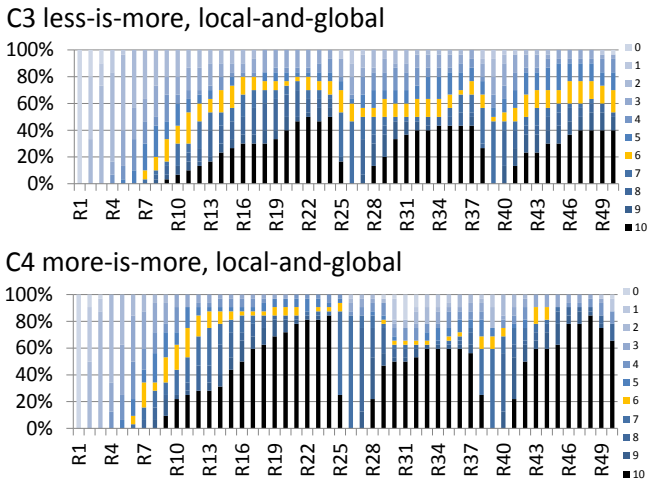

Figure 5: The proportion of hotel occurrences over the 50 rounds for the two global-and-local conditions run in Experiment 2 only.

Similar to Experiment 1, a surprisingly high proportion of 10-hotel occurrences remains in both conditions. As predicted, however, there seem to be fewer 10-hotel occurrences in the less-is-more condition than in the more-is-more condition. Nonetheless, there remains to be only a very low number of correct 6-hotel occurrences (or a similar number of occurrences) in the less-is-more condition.

Thus, even after adding the storm manipulation, a substantial proportion of participants in the less-is-more condition built too many hotels even in late rounds (e.g., R47).[1] Even with repeated experience that more hotels lead to lower payoff—and given clear global payoff information— it seems the more-is-more strategy stills plays a role in this less-is-more environment. Despite descriptive improvement between experiments, a relevant portion of participants demonstrate problems detecting externalities, involving a clear reduction of payoffs.

Experiment 3

Experiment 3 was highly similar to Experiment 2, with two main differences. First, it is explicitly and saliently suggested in the introduction that the number of hotels might be positive or also negative. Second, we investigated the full set of four conditions (as in Experiment 1) but employed 50 rounds, with 2 storms (as in Experiment 2).

Method

Participants 137 from the University of Heidelberg voluntarily took part, with the same incentives as in Experiments 1 and 2. 117 ended the game without going bankrupt. Again, we confine our analysis to these participants.

Material and Procedure The material and procedure for Experiment 3 are largely identical to those for Experiment 2. The instruction was aimed at increasing the plausibility of a potential interaction hypothesis between number of hotels and payoff. After mentioning the possibility of several influences on the payoff, the following was added: "*House building may for instance increase or also decrease the attractivity of the hotels* […]". The text was set in bold print (the only bold print in this paragraph).[2]

Results and Discussion

Figure 6, as with analogous figures in the previous Experiments, provides detailed information about the relative frequency of hotels build in the conditions and phases.

The results at least suggest the following. Over all conditions, the use of a partly unwarranted 'more-is-more' heuristic' seems less frequent (here generally linked to 10-hotel occurrences after hotels could be built up). Furthermore, the comparison of the two local-and-global information conditions (full information) shows testable differences between conditions, in a direction coherent with optimal decisions: in the less-is-more condition, particularly after the second storm, people favor about as many correct 6-hotel occurrences as 10-hotel occurrences. This is clearly not the case in the more-is-more condition (if one for instance tests these frequencies against each other in one round, e.g. R48, this yields significant results, exact four-field test, $p < .01$). People may have become increasingly influenced by the observed data. No such clear differentiation is found between the two local-only information conditions. Participants here do not seem to distinguish the local and the global payoff conditions. Nor do they seem clearly influenced by the 'local optimum strategy', favoring 3 hotels. A mixture of strategies, however, cannot be ruled out.

[1] Due to an instruction error, according to which the overall number of rounds was at one point mentioned to be 30 instead of 50, this presumably caused some people (few) to sell several hotels at this time. As in Experiment 1 this did not play a significant role for the local-and-global conditions.

[2] Another minor change was that we did not mention the option of removing hotels in the introduction in connection with winning money in a real lottery, but only on the local pages of places were hotels were built.

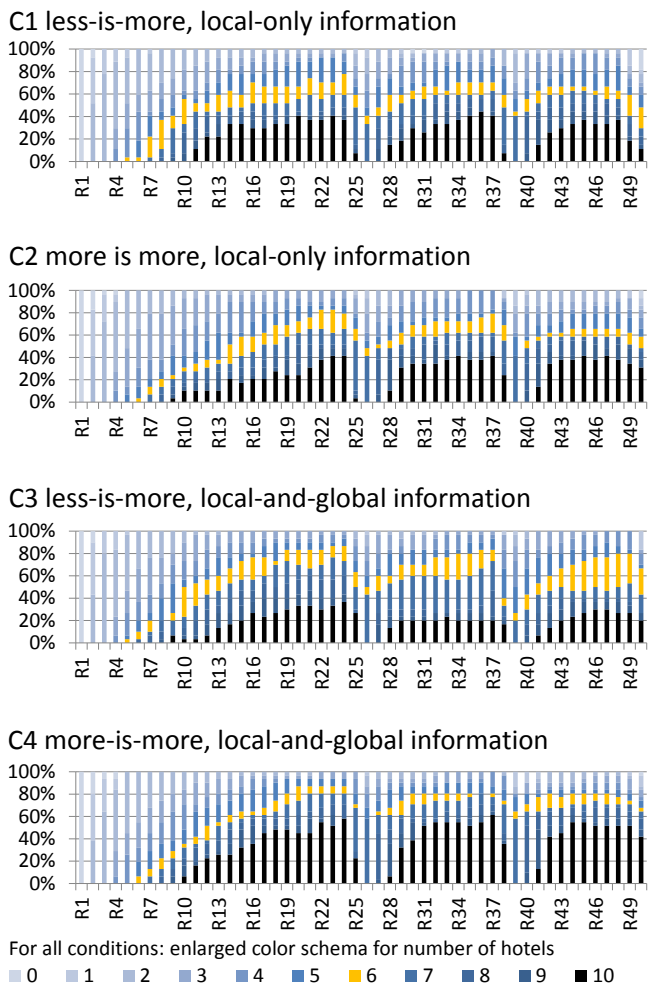

Figure 5: The proportion of hotel occurrences over the 50 rounds of Experiment 3 for all four conditions.

General Discussion

Overall, the results support the idea that there are inner-individual dilemmas that lead to optimizing local goals at the expense of global optimization. People can have substantial difficulties seeing mutual externalities (systematic negative side-effects of a class of positive effects) with regard to one's own payoffs. Such individual dilemma situations were studied here using the example of hotel-building, a context where analogous social dilemmas are well known; local optimization of over-building (whether too many or too high), can have detrimental effects on optimization at a higher level (e.g., tourist income for a city). In the social context this has not only been discussed by the media but has even led to regulations in several countries. (In Bali, for instance, it is forbidden to build new hotels taller than palm trees.)

For the inner-individual dilemmas studied here, Experiment 1 suggested that participants tend to follow a more-is-more strategy even in less-is-more situations. This was even the case when people were provided with salient information about *global* payoffs. Furthermore, Experiment 1 ruled out the adequacy of a different unwarranted local strategy, the local optimum strategy. Experiment 2 appears to show this even for more rounds and after repeatedly forcing participants to experience a negative relation between number of hotels and payoff. Experiment 3 added an explicit instruction, encouraging an externality hypothesis. Here finally the more-is-more strategy seems to play a smaller role, but this likewise only lead to a partial cure. Particularly, in conditions with only local feedback, people remain to have difficulties integrating their local knowledge.

The present research is not conclusive and raises many further questions. Notably, beyond the need for some clarification of some aspects of our results, the line of research opens up interesting new avenues. The formulation of inner-individual dilemmas in a broad analogy to social dilemmas may inspire research that may connect game theory, self-regulation (e.g., Baumeister & Vohs, 2004), causal decision making (e.g., Robinson, et al. 2010; Hagmayer & Meder, 2013), and the learning of interactions (e.g., Novick & Cheng, 2004).

Acknowledgments

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References

Baumeister, R. F. & Vohs, K. D. (2004) (Eds.), *Handbook of Self-Regulation*, Guilford Press.

Hardin, G. (1968). The Tragedy of the Commons. *Science*, 162 (3859), 1243–1248.

Fehr, E. & Schmidt, K. (1999). A Theory of Fairness, Competition, and Cooperation. *Quarterly Journal of Economics, 114*, 817–868. doi: 10.1162/003355399556151

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

Fehr, E. & Fischbacher, U. (2004). Social norms and human cooperation. *Trends in Cognitive Science, 8*, 185–190.

Novick, L. R., & Cheng, P. W. (2004). Assessing Interactive Causal Influence. *Psychological Review, 111*, 455–485.

Ostrom, E., Burger, J., Field, C. B., Norgaad, R. B., & Policansky, D. (1999). Revisiting the Commons: Local Lessons, Global Chalenges. *Science, 284* (5412), 278–282.

Hagmayer, Y., & Meder, B. (2013). Repeated causal decision making. Journal of Experimental Psychology: Learning, Memory, and Cognition, 39, 33–50. doi:10.1037/a0028643

Robinson, A. E., Sloman, S. A., Hagmayer, Y., & Hertzog, C. K. (2010). Causality in solving economic problems. *The Journal of Problem Solving, 3(1)*, 6. 106–130.

Sober & Wilson (1999). *Unto Others. The Evolution of Unselfish Behavior*. Harvard University Press.

von Sydow, Momme (2012). *From Darwinian Metaphysics towards Understanding the Evolution of Evolutionary Mechanisms*. Göttingen: Universitätsverlag Göttingen.

Wilson, D. S.; Wilson, E. O. (2007). Rethinking the theoretical foundation of sociobiology. *Quarterly Review of Biology, 82*(4), 2007, 327–348. doi: 10.1086/522809