Self-Regulation of Common Property Resources: Cognitive Prerequisites for System Sustainability

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Abstract:

Common property resources (CPR) such as international fisheries, rainforests or the atmosphere, are not subject to well defined and enforceable property rights. In many cases this leads to an overuse and degradation of the CPR, whereas in other cases users avoid a tragedy of the commons (Hardin, 1968) by successfully (self-)regulating their behavior (Ostrom et al., 1994). As external institutional factors can only partially explain sustainable resource extraction, we propose an experimental examination of the internal, cognitive factors shaping the sustainable use of CPRs. Strategic considerations, system understanding and social preferences interact to determine individual extraction behavior. The proposed project aims at experimentally manipulating the availability of cognitive capacities in order to disentangle previously confounded behavioral drivers. This interdisciplinary approach is a crucial first step for defining a larger set of research questions in the nascent literature on the cognitive underpinnings of cooperation (Roch et al., 2000; Rand et al. 2012). Many CPRs constitute a dynamic system, whose determinants might be difficult to understand: Future extraction is limited by the current stock (e.g., number of fish) and the relation between reproduction and extraction. We

propose a link between abstraction capabilities and system comprehension. Specifically, higher-level abstraction focusing on the relations between system elements (e.g., “how does extraction relate to reproduction?”) as opposed to lower-level abstraction focusing on isolated system elements (e.g., “how big is the momentary extraction?”) is a likely prerequisite for system comprehension. In a situation in which strategic incentives cause a conflict between individual and collective interests, sustainable extraction is hard to maintain, even when users understand the consequences of their actions. Both behaviors are likely related to cognitive control resources that restrain giving in to tempting impulses (Shiv & Fedorikhin, 1999, 2002; Friese, Wänke & Plessner, 2006). A better understanding of the cognitive mechanisms governing selfregulation in CPRs can contribute to a better management of these resources. We argue for extending the research on CPRs by a cognitive perspective. Specifically, we aim to shed new light on self-regulation in CPRs along the lines of (1) higher-versus lower-level abstraction and (2) cognitive resources for selfcontrol.

Self-regulation of common property resources: Working memory capacity – Can there be too much of a good thing?

Laufzeit: Mai 2016 – Februar 2017

Abstract:

In our previous FoF4 Project “Self-Regulation of Common Property Resources: Cognitive Prerequisites for System Sustainability” we have initiated an experimental investigation into the cognitive drivers of extraction behavior in common pool resources (CPR) dilemmas. CPRs such as international fisheries, rainforests or the atmosphere, are not subject to well-defined and enforceable property rights. In

many cases this leads to an overuse and potential degradation of the CPR, whereas in other cases users avoid a tragedy of the commons (Hardin, 1968) by successfully (self-) regulating their behavior (Ostrom et al.,1994). In the proposed project we plan to expand on our previous FoF4-funded experiment suggesting that cognitive factors may explain individual heterogeneity in CPR (over-)use. In our previous research, we found promising evidence that both self-control resources and working memory capacity (WMC) act as key drivers of individual extraction behavior. In these experiments, we investigated individual extraction choices in a dynamic CPR task with a renewable resource that grew exponentially over five rounds. Higher WMC participants made better (i.e., delayed) extraction choices when they were the sole user of the resource. When a group of four participants interacted with the common resource, however, higher WMC participants were more likely to extract unsustainably high amounts in the first round, thereby initiating a premature break-down of the resource. Similarly, forcing subjects to decide under high cognitive load lead to worse outcomes in the single user case, but induced more sustainable resource use in the group case. Thus, in our setting the individually rational behavior of high WMC participants proved a key driver of the tragedy of the commons. This result is noteworthy in light of a large existing literature, which typically sees higher WMC as a key driver of optimally self-regulated behavior. We aim at following up on these previous experiments funded by FoF4 in order to isolate the causal mechanism that could link WMC to suboptimal behavior in a group setting. Individual WMC is known to be a key element of human self-regulation ability, and should thus be a key determinant of sustainable resource use. Could it be the case that simple heuristics that are not WM-intensive are a better guide to socially optimal resource use than strategic behavior that draws on more complex strategies like backward induction? Our question is linked to a current literature (see Cowan, 2010) that investigates why human WMC is actually severely limited. One prominent theory postulates that it is an evolutionary advantage to limit WMC since this enables humans to interact successfully in social settings. This explanation would be in line with our existing results: Human—limited—WMC might be optimal in the sense of being large enough to allow for self-regulated use of individually used resources, and being small enough to restrain extreme forms of individual rationality when interacting with a shared resource.

Using Agent-Based Modeling for Exploration of the Influence of Working Memory Capacity in CPR Dilemmas

Projektleitung:
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Abstract:

Our atmosphere, water or international fisheries are common pool resources (CPR). These resources are not subject to externally enforceable property rights and can in principle be used by everyone. As those resources are limited, individual extraction decisions can lead to an overuse and, consequently, to a breakdown of the resource. In our research we are interested in cognitive factors which influence people's extraction behavior. In previous experiments we identified the working memory capacity (WMC) as a key driver of individual extraction behavior. The term “working memory” refers to people’s ability to hold, process, and manipulate information. The amount ofinformation that can be processed in this way is limited to about 7 items. A high working memory capacity is usually related to a variety of cognitive abilities including general intelligence.

We showed in a dynamic CPR task with a renewable resource that grew exponentially over five rounds that individual extraction choices were better (i.e.,

delayed) for higher WMC participants when they were the sole users of a resource. But when a group interacted with acommon resource, higher WMC participants were more likely to extract unsustainably high amounts in the first round, causing a premature breakdown of the resource. These results suggest that human WMC limits might actually be adaptive and might have been favored evolutionarily in the past due to more sustainable resource use in group settings. Albeit these results are highly suggestive, they are necessarily correlational in nature. A crucial next step therefore is to use a mathematical modeling approach that allows us to vary WMC (and only WMC) in a controlled way for simulated agents interacting with a CPR.

Our modeling approach is called agent-based modeling (ABM), a method to computationally study individual behaviors and how these behaviors affect others as well as theenvironment. An agent-based model typically consists of three elements: 1. Agents, with specificattributes and behaviors. 2. Agent relationships and methods of interaction. 3. Agents' environment, in which agents live in and interact with. ABM allows us to simulate the interaction of agents with each other, with a common resource, and with the containing environment over time.

By implementing the same dynamic CPR task that was used in the previous experiments, we will be able to compare the simulation results and the experimental results from our previous study. The interaction of the agents with the resource will be simulated. In order to assess the influence of WMC on performance, the application of mathematical optimization methods is mandatory. Using mathematical optimization, we will be able to make quantitative statements about optimal parameter values for different scenarios. This will allow us to investigate the optimal level of working memory capacity for sustainable resource use, and thus to investigate the fundamentalquestion of whether a more limited human working memory capacity might prove beneficial for common resource use.