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# MANAGEMENT OF COMMON POOL RESOURCES IN A NATION-WIDE EXPERIMENT

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## Abstract

Dilemmas related to the use of environmental resources concern diverse populations at local or global scales. Frequently, individuals are unable to visualize the consequences of their actions, where they belong in the decision-making line, and have no information about past choices or the time horizon. We design a new one-shot extraction game to capture these dynamic decisions. We present results from a nationwide common pool resource experiment, conducted simultaneously in eleven French cities, involving a total of 2813 participants. We examine, for the first time, the simultaneous impact of several variables on the amount of resource extracted: the local vs. the national scale of the resource, the size of the group (small vs. big), the low vs. high recovery rate of the resource, and the available information. We show that individuals significantly reduce extraction levels in local as compared to national level dilemmas and that providing recommendations on sustainable extraction amounts significantly improves the sustainability of the resource. Overall, women extract significantly less, but care more about preserving the local resource; older participants extract significantly more resources but extract less from the national resource. Our experiment also fulfills a science popularization pedagogical aim, which we discuss.

**Keywords:** Common pool resource; experiment; large sample; science popularization.

**JEL Classification:** C93, Q22, Q23

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## 1. Introduction

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11 27 Many prominent cases of social dilemmas, such as global warming, overfishing of the  
12 28 oceans, or deforestation, occur on global or international scales. Frequently, in such situations,  
13 29 individuals are unable to visualize the consequences of their actions, as they are distantly far.  
14 30 Moreover, most environmental consequences take time to happen, and individuals cannot see the  
15 31 history of their behaviors, the complete time horizon, nor their position in the timeline of  
16 32 succeeding decision makers. Meanwhile, research about behavior in social dilemmas in controlled  
17 33 laboratory experiments is often restricted to small, homogenous subject pools, where participants  
18 34 are given specific information about own and others' actions and clear timelines and time horizons.  
19 35 This begs for the question of the internal and external validity of results with respect to situations  
20 36 involving hundreds or thousands of individuals at a national or international scale with no visibility  
21 37 regarding history and time horizon. This paper is meant to bridge this gap by providing insights  
22 38 and presenting empirical evidence on behavior in a common pool resource dilemma collected  
23 39 through a national experiment, which is our first contribution. We study behavior for a large  
24 40 nationwide experiment, conducted simultaneously in eleven French cities, involving 2813  
25 41 participants from the general population (2641 complete observations aged 10 to 91<sup>1</sup>). The large  
26 42 heterogeneity of our subject pool, both regarding individual and location characteristics, allows us  
27 43 to investigate what drives extraction decisions. We modify the standard common pool game as to  
28 44 account for the impossibility of the visualization of history and time horizon. This allows us, within  
29 45 a one-shot game, to study dynamic features, which is our second contribution.  
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48 47 While previous experimental research has separately discussed how contributions in social  
49 48 dilemmas are influenced by group size (e.g. Isaac and Walker, 1988; Isaac et al., 1994) and by  
50 49 social distance (Cardenas and Carpenter, 2008), we extend this line of research to a setting  
51 50 characteristic of a real common pool resource problem, where a resource is either accessible to a  
52 51 small, local community or to a large, national community, since group size and social distance are  
53 52 strongly linked in many real-life situations. Therefore, our third contribution is that our paper

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60 <sup>1</sup> See Sutter et al. 2019 for experiments with children and teenagers and their inclusion or exclusion from the dataset).

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4 53 inquires those two effects in combination. We consider a situation that modifies the scale where  
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6 54 the resource is extracted (local vs. national) together with the group size (the number of individuals  
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8 55 having access to it). This resembles characteristics of common pool resources, where increased  
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10 56 size (e.g. fishing from a lake versus fishing from the sea) implies that the other involved parties  
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12 57 belong to different communities, groups or cultures. This allow us to investigate to which degree  
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14 58 extraction decisions are influenced by the accessibility of the resource. We finally also vary the  
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16 59 recovery rate of the resource (high or low) and examine the impact of a recommendation regarding  
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18 60 the sustainable extraction level of the resource.  
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21 62 Common pool resource dilemmas have been extensively studied in economics (e.g. Ostrom  
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23 63 et al., 1994, 2006). Experiments initially used mainly a single period design, investigating general  
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25 64 behavior and the effectiveness of various institutions, e.g. communication (Ostrom et al., 1994;  
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27 65 Cardenas, 2000) and sanctioning mechanisms (Casari and Plott, 2003). Dynamic experiments (e.g.  
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29 66 Herr et al., 1997; Chermak and Krause, 2002), involving several successive generations, observed  
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31 67 "temporally myopic" (i.e. egocentric) behavior. This is true for decisions in the lab (Fischer et al.,  
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33 68 2004) as well as for decisions involving the fishing of actual fish (Noussair et al., 2015). Our design  
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35 69 is partially inspired by Fischer et al. (2004). In their framework, each participant belongs to a three-  
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37 70 player generation and is allowed to extract a resource from a common pool. The stock available to  
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39 71 each generation depends on the extent of exploitation by previous generations and on a commonly  
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41 72 known resource recovery rate, which can be either slow or fast. When the recovery rate of the  
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43 73 resource is slow, free-riding increases. In the same vein, our design involves several interacting  
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45 74 generations. Since our purpose is to compare behavior on a large (national) to a small (local) scale,  
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47 75 we examine two environments: one with generations from large, national groups of 100  
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49 76 participants, and one with small, local groups of 10 participants. We additionally vary across  
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51 77 treatments the availability of a recommendation to participants.  
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54 79 Our treatment variations (size of the group, local vs. national scale, availability of a  
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56 80 recommendation) help us induce a group identity, or what is lately called in the literature a “we-  
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58 81 intentionality” (Guilbert, 2009), or “team-reasoning” (Sugden, 2003). Indeed, in order to activate  
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60 82 this team reasoning, in the terms of Gilbert, we need to “address the we”: this requires anchoring  
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62 83 and framing meant to help individuals endorse that identity (Zahavi, 2021).  
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Therefore, in our experimental design, large, national, or small, local, generations of players succeed each other, and have the possibility to extract two separate finite resources whose recovery rates are common knowledge. In each treatment participants were asked to make two independent extractions, one at the local level and one at the national level. It was specified that, at the end of the experiment, participants would be randomly placed either in a generation of 100 participants at the national level or in a generation of 10 participants at the local level.<sup>2</sup> Across participants, we varied whether the resource was characterized by a low (resource framed as “trees”) or high (resource framed as “fish”) recovery rate. This mimics reality, as fish matures more quickly than trees, and is easily understood by the general public. We further varied whether participants received recommendations on the maximum number of resource units to be extracted by each individual to ensure the sustainability of the resource. We also collected demographic data (gender and age) in order to (dis)confirm previous findings about lower extractions by women in CPR contexts (Agarwal, 2009; Revollo-Fernandez et al., 2016) and an U-shape effect of age on extractions (Handberg and Angelsen, 2015).

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Our results show that the extraction rates are significantly higher when the resource is shared at the national level, when the recovery rate of the resource is high, and when participants don’t receive a recommendation on how much to extract. More precisely, the recommendation affects the choice of participants when the resource recovery rate is low. In this case, the number of resource units extracted is significantly lower than when no recommendation is made. Our results also show that, on average, women extract significantly less and older people extract significantly more resources. While women extract significantly less from the resource at the local level, we find the opposite relationship for older participants. This means that older individuals are more inclined to protect a national resource. Our results lead to several recommendations in terms of public policies aimed at improving the management of common resources. Our experiment also involved a science popularization purpose, in the form of an original transfer of knowledge to a non-specialized public, and an opportunity for the public to learn and to be sensibilized to current economic issues.

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<sup>2</sup> Participants did not know to which generation they belonged, nor how many generations were before or after them.

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The remainder of this paper is organized as to explain our experimental constraints, the features of our design, the experimental procedures, the hypotheses and report the results. We also draw public policy proposals and discuss how our setup can be used for science popularization.

## 2. Experimental and popularization constraints

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This experiment was selected during the 2015 call for projects for a "large participative experiment", within the framework of the tenth European Researcher's Night in France. Such an event involves specific constraints (see Lohéac et al., 2017)<sup>3</sup>, therefore the experiment needs to translate into a playful encounter between researchers and the public. It allows the public to meet researchers from their city and to exchange with them on their work.<sup>4</sup> The "participative experiments" must be carried out in all the cities involved in parallel, with a large number of participants in a single evening. It should also contribute to the communication of scientific insights to the large public and thus must be simple and understandable by a large range of participants. From this setup, a number of logistical constraints arise. The instructions need to: be short and easily understandable by a non-expert public; impose minimal technical constraints related to either technical skills or equipment (e.g. smartphones); be sufficiently flexible to adapt to an uncertain and variable number of participants per session. It is important to understand in detail these constraints, as this specific feature of our work expands the purpose of the experiment itself, while extending its external validity as well, and increasing its intended value creation.

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Data collection methods have diversified in behavioral economics to test or strengthen the external validity of laboratory experiments (field experiments, large-scale randomized trials, experiments in "natural" settings, neuroeconomics experiments, etc.). Internal and external validity

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<sup>3</sup> The project had to meet the following four objectives as imposed by the funding organizations: (i) our scientific and academic objective was to analyze individual decision making in the presence of treatment variations; (ii) which had to lead to scientific dissemination of the findings through specialized academic publications; (iii) in addition the project had to constitute an original transfer of knowledge to a non-specialized public, and constitute an opportunity for the public to learn and to be sensibilized to current economic issues; (iv) and finally, this project had to be a methodological contribution (i.e. the implementation of a valid experimental method given the constraints regarding participants) in order to share these methods and to enable future investigations of a similar type.

<sup>4</sup> In the year of the experiment, the following French cities were involved: Angers, Besançon, Bordeaux, Brest, Dijon, Le Mans, Limoges, Lyon, Metz, Paris and Toulouse.

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4 137 of experiments are an important issue discussed in experimental economics (Harrison and List,  
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6 138 2004). We address external validity as a complement to external relevance, i.e. we perform a  
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8 139 robustness check on large and age diverse sample, which is generally aware of environmental  
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10 140 issues such as those scenarized in our experiments, and not a study on a specific population (i.e.  
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12 141 fishermen or lumberjacks). Moreover, we target populations with a pre-established identity  
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14 142 (inhabitants from each city) as to highlight group identity when exposed to a social dilemma. It is  
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16 143 externally relevant as individuals perceive easily the local dimension of the decision and visualize  
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18 144 better the national dimension as well. Sheppard (2005) suggests using mechanisms (including  
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20 145 visual mechanisms) to illustrate the medium and long term consequences of our lifestyle to reduce  
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22 146 the psychological distance from behaviors and reach the general public. Furthermore, maintaining  
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24 147 a familiar and real environment has been found to be a precursor to pro-environmental behaviors  
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26 148 (Scannell and Gifford, 2013). Our solution was to make appeal at simpler images (cutting trees,  
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28 149 fishing...). Therefore, participants experience less cognitive costs to understand their role.  
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30 150 Following Greenberg and Tomlinson (2004), we balance in our design artificiality and familiarity:  
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32 151 even if individuals do not cut tree in their real-life, they will understand more easily the scenario  
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34 152 than a standard abstract extraction game. In addition, we believe that "one of the major reasons for  
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36 153 conducting experimental research is not to determine what actually happens in the field, but to test  
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38 154 inductively derived hypotheses regarding what might happen under certain conditions (Greenberg  
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40 155 and Folger, 1988)."

39 156 At the same time, our discipline has extended to the field of pedagogy (Eber and Willinger,  
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41 157 2012). For instance, many experiments are conducted in the classroom to teach and illustrate  
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43 158 economic concepts (e.g. Holt, 1995). In this paper, we present an extension of the discipline into  
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45 159 two directions. First, a general public event allows the collection of a massive amount of data over  
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47 160 a short period of time. Second, the event can be seen as a pedagogical exercise aimed at a general  
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49 161 public. The immersion into the common good problem during the experiment allows us to explain  
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51 162 a complex contemporary economic problem and its mechanism to the general public and not, as  
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53 163 usual, to students. This is especially relevant given the reported weaknesses regarding the  
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55 164 dissemination of the progress of economic science in secondary schools (Guesnerie, 2008).

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4 168 It is now common, when it comes to experimental methodology in economics, that three  
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6 169 categories of objectives are cited (following Roth, 1986, 1988, 1995): testing theory, finding facts,  
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8 170 and advising decision makers. We add, in this paper, a fourth objective: disseminating science to  
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10 171 the larger "public", represented by our experimental participants, while respecting the rules of the  
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12 172 discipline (experimental control, anonymity, monetary incentives, etc.). This is essential, especially  
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14 173 nowadays, as pro-environmental behaviors can only be enhanced when arguments are supported  
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16 174 by scientific facts (Muradian and Pascual, 2020).  
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19 176 Setting up an experiment in a context that is both an experimental lab-in-the-field and a  
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21 177 "stage" implies the transmission of tacit knowledge in the sense of Polanyi (1967), and therefore,  
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23 178 it requires that, in parallel with the regular transmission of the experimental instructions, two other  
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25 179 transmissions occur: the explanation of the experimental design and the explanation of the practices  
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27 180 and skills that made possible the creation of such a design, which are usually hidden from those  
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29 181 who are not experts. The goal was to create an experiential learning framework for the audience.  
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31 182 Referring to Kolb's (1984) learning theory, experiential learning is effective in providing this  
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33 183 transmission as the public becomes an actor in the decision making. We therefore engaged the  
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35 184 audience (our experimental subjects) into an "experiential approach", and the encounter was based  
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37 185 on three principles: (i) the involvement of the public in the exchange with the researcher (through  
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39 186 participation in the experimental game), (ii) a co-construction of the knowledge conveyed in the  
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41 187 exchanges, by the explanation, afterwards, of the method and the objectives of the experiment, and  
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43 188 (iii) a strong commitment of the public to learning, by focusing on intrinsically motivated  
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45 189 individuals that attended a scientific popularization event, combined with real incentives, as in a  
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47 190 regular laboratory experiment, on a topic for which the public was likely to be sensitive.  
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49 191 Overexploitation of natural resources is one of the biggest challenges for societies around the globe  
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51 192 and we therefore deployed a simplified common pool resources experiment aimed at reproducing  
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53 193 the tragedy of the commons.  
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56 195 The implementation imposed a certain number of logistical constraints. It was necessary to  
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58 196 gather a large enough team of scientists, available and able of conducting the experiment in eleven  
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60 197 cities, as in such events, the public expects to meet "real" researchers who could talk about their  
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62 198 research. It was further necessary to use a short experimental protocol, easily understandable by  
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4 199 people of all ages, and without digital requirements regarding the use of mobile devices or  
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6 200 computers, such as to ensure that attendance is non-exclusive. It was also necessary to design an  
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8 201 experiment that includes the possibility of an ex-post exchange about its purpose and implications,  
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10 202 as the participants main reason to attend the event was to learn through the scientific dissemination  
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12 203 of the results. We had to respect the canons of the experimental method regarding instructions,  
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14 204 control and replicability. Finally, the design had to be flexible enough to adapt to an uncertain and  
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16 205 variable number of participants, as the experiment was going to be implemented in very different  
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18 206 places (large amphitheaters that could accommodate hundreds of people, small rooms with a fixed  
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20 207 number of people per session, public places, etc.), which resulted in the design of an experiment  
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22 208 that could be conducted within sessions of different sizes (which is not standard in our field).  
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24 210 The experimental parameters and treatments were developed and tested in numerous pilot  
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26 211 sessions during 10 months before the implementation of the experiment. The instructions were  
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28 212 carefully tested with various testing groups. The tragedy of the commons was chosen as the topic  
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30 213 was familiar to the research community and many experiments have studied it in a variety of  
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32 214 contexts (from student samples to field experiments with farmers or fishermen, see for example  
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34 215 Cardenas et al. 2013; Ostrom, 2006). The topic concerns also a timely issue that concerns citizens  
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36 216 and is often debated by public or private decision-makers (elected politicians, representatives of  
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38 217 civil society, etc.), who intend to increase the willingness of individuals to move towards  
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40 218 sustainability (Ostrom, 1999). We could therefore expect that the topic would be easily understood  
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42 219 by our participants. Finally, the tragedy of the commons can be formalized with an easy  
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44 220 understandable game (Gordon, 1954), where the desire of each individual to maximize his/her  
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46 221 individual gain is at the detriment of a socially optimal solution. It provides an ideal framework to  
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48 222 illustrate how behavior can be modeled and anticipated with economic tools.

### 49 50 224 **3. Design specifications**

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52 225  
53 226 In order to keep the design simple and relevant for the European researchers' night, we  
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55 227 focused on three variables. The first variable is the rate of recovery of the resource (low or high).  
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57 228 This element is easily integrated by the public who is aware that natural, depletable resources might  
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59 229 renew themselves either quickly or slowly, dependent on type. The second variable is the

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230 information available to individuals regarding the thresholds of sustainability with respect to the  
231 exploitation of these resources. This mimics media or policy campaigns aimed at raising awareness  
232 of sustainable exploitations levels for exotic woods or fish, for instance. Finally, the third variable  
233 is the scale of availability of the resource, i.e. whether it is local or on a national scale. The  
234 experiment was taking place in 11 French cities, and the public was aware of it, so this dimension  
235 was easy to explain: the local scale was a specific city, and the national scale were the eleven cities.

237 Our experiment presented a multigenerational common pool resource game to participants.  
238 Participants were informed about the initial resource level available in the first period and about  
239 the recovery rate of the resource. The novelty is that our game differs from the standard public  
240 good or common-pool resource games previously studied in the literature as it combines  
241 simultaneously the recovery rate variation, the information available and the scale of the resource  
242 at the local or national levels with a veil of ignorance regarding one's position in the line of  
243 generations. Specifically, only at the end of all experimental sessions, participants were randomly  
244 allocated to their generations and earnings were calculated. This setup allows us to keep the  
245 expected situations constant for all participants, independent of the timing of their sessions. When  
246 selecting this specific design, we build on several related papers. A similar extraction design was  
247 implemented by Fischer et al. (2004) with small groups of three individuals who were or not part  
248 of a sequence of four generations. As compared to thier paper, the novelty of our design is the  
249 unknown number of generations, as well as a variable group size and the local vs. the national  
250 availability of the resource. Hauser et al. (2014) conducted an extraction game in which the  
251 resource for the next generation depended on the extraction by the previous generation and voting,  
252 but the existence of the next generation depended as well on a termination probability. Our design  
253 simplifies this design as all generations exist, yet cannot extract, depending on the availability of  
254 the resource and not on an ex-ante probability. Ajdukovic et al (2019) designed an experiment with  
255 a finite known horizon but with uncertainty about one's position in the timeline and Timilsina et  
256 al. (2017) and Timilsina et al. (2022) conducted field experiments on intragenerational deliberation.  
257 Our design incorporates a more realistic uncertain time horizon.

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259 This design allows us to manage sessions of different sizes, and to avoid contagion effects inside  
260 the experimental rooms (participants willing to discuss and take joint decisions), because even

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261 participants present in the experiment at the same time will not be allocated necessarily to the same  
262 generation, which is dissuasive in terms of communication attempts (while in sessions in which  
263 necessarily all players play inside the same generation, there is a risk of participants willing to  
264 communicate among them). This feature helps participants understand that the optimal strategy is  
265 to play their preference independent of a clear information about their situation in earlier or future  
266 generations, as they may be themselves in early or late generations (there is no strategic decision).

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268 Our design is closer to the spirit of the Rawls' critique as presented in Wolf and Dron (2020),  
269 who implemented a dictator game with a veil of ignorance about one's position in the sequence.  
270 Indeed, if an individual knows his/her position in a generation sequence, the action taken cannot  
271 be impartial, as it takes advantage of the "dictatorship of the present" (Georgescu-Roegen, 1975):  
272 individuals taking decisions today have an advantage over the individuals from the future because,  
273 as in the dictator game, they decide about all the outcomes, while the future individuals do not have  
274 the possibility to retaliate (as they do not exist today) and are passive recipients of the decisions  
275 taken today, as recipients in the dictator game. If individuals have no certainty about operating in  
276 the present, they cannot be sure they can act as dictators. They are maybe themselves recipients at  
277 some point of other individuals. This veil of ignorance forces, by backward induction, to more  
278 ethical decisions.

279  
280 Finally, this allows us to compose a hybrid game (a one-shot game with a dynamic  
281 implication offered by the uncertainty about the time horizon, the rank of a generation and past  
282 decisions), where individuals do not know what position they have in the common pool resource  
283 extraction line, and the length of the decision horizon, which reproduce the decision-making  
284 situation from "the real life". This was clearly explained orally to the participants and the exact  
285 wording from the instructions stated that "some generations are preceding you and some other are  
286 following you" (see Appendix A).

287  
288 We examine three different treatment variations. The treatment variations concern: (1)  
289 whether the game was played with a small-size group, on a local scale (10 participants from the  
290 same city per generation) or with a large size group, on a national scale (100 participants from the  
291 eleven cities per generation) (*Local* versus *National*), (2) the recovery rate of the common pool

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4 292 resource (*High* versus *Low*); (3) and whether recommendations on sustainable extraction levels  
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6 293 were provided to participants (*Recommendation* versus *No Recommendation*). In the experiment,  
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8 294 the first treatment dimension (*Local* versus *National*) was conducted at a within-subject level, while  
9  
10 295 the last two treatment variations (*High* versus *Low* and *Recommendation* versus *No*  
11  
12 296 *Recommendation*) were conducted at a between subject level (see Table 2). As an example, one  
13  
14 297 recommendation given to participants was: "In order to ensure that future generations have at least  
15  
16 298 the same stock of fish as you have, it is recommended that no more than 3 fish are caught by each  
17  
18 299 fisherman in each location."  
19  
20 300

21 301 The resource ( $R$ ) in treatment *High* recovered at a rate of 1.15, and thus evolved according  
22  
23 302 to the following rule:

$$R^{t+1} = 1.15 * (R^t - x^t)$$

24  
25  
26 303 where  $x^t$  is total extraction at time  $t$ . To keep the sustainable extraction level constant across  
27  
28 304 the *Local* and *National* game, the initial stock of the resource was either 230 (*Local*) or 2300  
29  
30 305 (*National*) to adjust for the difference in the number of participants per generation (either 10 in  
31  
32 306 *Local* or 100 in *National*). As can be easily verified, growth compensation requires that total  
33  
34 307 extraction per generation should be 30 in *Local* and 300 in *National*. Assuming symmetric  
35  
36 308 extraction choices, this translates into a sustainable extraction effort per individual of 3 units.  
37  
38 309

39 310 Similarly, the resource in treatment *Low* recovered at a rate of 1.05, and thus evolved  
40  
41 311 according to the rule:

$$R^{t+1} = 1.05 * (R^t - x^t)$$

42  
43  
44 312 where  $x^t$  is total extraction at time  $t$ . In this case growth compensation requires that total extraction  
45  
46 313 per generation should be 10 in *Local* and 100 in *National*. Assuming symmetric extraction choices,  
47  
48 314 this translates therefore into a sustainable extraction effort per individual of 1 unit.  
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50 315

#### 51 316 52 317 **4. Hypotheses** 53 54 318

55 319 We investigate three hypotheses:  
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59 320 *Hypothesis 1: Extraction rates are lower at the local scale than at the national scale.*  
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321 *Hypothesis 2: Less resource is extracted when the recovery rate is low.*

322 *Hypothesis 3: Providing a recommendation lowers the extraction rates.*

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324 Hypothesis 1 is motivated by the fact that our first aim is to explore how extractions are  
325 influenced by interacting either on a large, national scale or on a small, local scale. Notably, a  
326 resource available to a larger group of individuals will almost by definition include individuals that  
327 are more remote and unknown. We do not intend to disentangle the effects of group size and the  
328 local vs. national scale of the resource separately, as this was already investigated in the literature  
329 cited hereafter.

330  
331 Common pool resource situations introduce a competitive environment that makes such  
332 situations different from other types of social dilemmas (Apesteguia and Mayer-Rigaud, 2006).<sup>5</sup>  
333 In the case of voluntary contributions to a public good, Zelmer (2003)’s meta-analysis found no  
334 effect of group size on average contributions. However, recent papers confirmed Isaac et al.  
335 (1994)’s finding that large groups (40 or 100 participants) contribute more on average than small  
336 groups (4 or 10 participants) when the marginal per capita return (MPCR) is low.<sup>6</sup> In common pool  
337 resource experiments, several papers found a negative group size effect: larger groups preserve less  
338 the resource, in accordance with Olson (1965)’s conjecture. Brewer and Kramer (1986) compared  
339 groups of 8 and groups of 32 participants and observed larger average extractions in large groups.  
340 Nevertheless, the size effect in common pool resource games remains an open question, as several  
341 empirical papers suggested that the relation between group size and resource conservation is non-  
342 linear (e.g., Ostrom, 2002; Gautam, 2007; Yang et al., 2013).

343  
344 In addition to a group size effect, the transition from a local to a national scale is often  
345 accompanied by a greater average social distance between individuals. Indeed, while it is possible  
346 that a participant knows individuals from further generations at the local level, this is less likely at

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<sup>5</sup> A similar effect is discussed as the “give” versus “take” frame (e.g. Gächter et al., 2017).

<sup>6</sup> Diederich et al. (2016) found a positive group size effect with heterogeneous groups of individuals from the general population. They compared groups of 10, 40 and 100 and found that cooperation increases with group size. Weimann et al. (2019) obtain a similar result with student samples with very small MPCR values: groups of 100 contribute more on average than groups of 60. Finally, Pereda et al. (2019) also found a similar group size effect, although they rely on a different public good game.

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4 347 the national level<sup>7</sup>. Previous studies have shown that reducing social distance tends to increase  
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6 348 cooperation in social dilemmas and information about past cooperativeness of (un)related groups  
7  
8 349 affects cooperation in problems of collective action (Bohnet and Frey, 1999; Boone et al., 2008,  
9  
10 350 Engel et al. 2021). Considering these results, previous results from common pool resource  
11  
12 351 experiments, and the fact that each extracted unit from the local and the national resource generates  
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14 352 the same reward, we expect participants to extract a lower quantity at the local scale as compared  
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16 353 to the national scale.

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19 355 Hypothesis 2 is motivated by the fact that our second aim is to study how extractions depend  
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21 356 on the recovery rate of the resource. Following Fischer et al. (2004) and Osés-Eraso et al. (2008),  
22  
23 357 we hypothesize that extractions will be lower when participants face a low recovery rate. In the  
24  
25 358 previous section we noted that a lower recovery rate translates into a lower sustainable extraction  
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27 359 level. Participants aware of this should therefore extract less when recovery rates are low.

28 360  
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30 361 Hypothesis 3 is grounded on the principle of transmission of scientific knowledge to the large  
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32 362 public. Making participants aware of the sustainable extraction level through a recommendation is  
33  
34 363 likely to affect their extraction behavior. We vary across treatments whether a recommendation on  
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36 364 the sustainable extraction amount is explicitly provided (*Recommendation*) or not (*No*  
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38 365 *Recommendation*).

39 366  
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41 367 Recommended play can function as a coordination device (Brandts and McLeod, 1995; Van  
42  
43 368 Huyck, et al. 1992; Croson and Marks, 2001; Chaudhuri and Paichayontvijit, 2010). For instance,  
44  
45 369 Croson and Marks (2001) found that recommended play leads to efficient contributions in step-  
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47 370 level public goods experiments when players have heterogeneous valuations for the public good.  
48  
49 371 Chaudhuri and Paichayontvijit (2010) found that recommending playing the payoff-dominant  
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51 372 strategy in the weakest link game leads to the efficient equilibrium in fixed groups if the  
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53 373 recommendation is "common knowledge" (i.e., all members of the group receive the same message  
54  
55 374 which is read out loud for everyone to hear). In intergenerational ultimatum games, Schotter and  
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57 375 Sopher (2003) found that an advice to the current generation by previous generations is followed  
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59 376 by a majority of participants, and it is welfare improving.

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<sup>7</sup> See the exact wording for local vs. national in the first paragraph of Appendix A.

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More related to our social dilemma game, several papers introduced "advice" treatments in experiments on public goods games. Chaudhuri et al. (2006) found that in an intergenerational voluntary contribution experiment, advice was welfare improving, if it is common knowledge (read aloud by the experimenter). Recently, Chaudhuri and Paichayontvijit (2017) also found that a publicly provided advice by the experimenter has a stronger effect on increasing contributions than the standard peer punishment option in voluntary contribution games. Regarding common pool resource games, Mantilla (2015) found, in a non-linear common pool extraction game, that recommendations to extract the socially desirable amount are non-credible among actual users of a fishery, and therefore they are not efficiency-enhancing. The non-linearity in the payoffs function increases the benefits of deviating from this advice, in particular if the other group members follow it. Since the payoff structure in our common pool extraction game is linear, the findings of the experimental literature about advice in public goods games is much closer to our experimental setting. Based on the aforementioned findings of the experimental literature, we expected that providing a recommendation in our context would lead to lower extractions, i.e. extractions that would be closer to the optimum level<sup>8</sup>. Moreover, note that in all treatments, participants were provided with the recovery rate of the resource<sup>9</sup>, so even in the absence of a recommendation, they could still compute the sustainable extraction level. However, previous experiments have shown that limited cognitive abilities of participants can prevent them from optimal decisions, especially when the information is too complex (Camerer, 1998). Also, Botelho et al. (2014) have shown that when the size of the resource is uncertain, participants move away from the optimal level of consumption and consume more resources. If we consider that this uncertainty can be also associated to complexity for some participants, we might expect participants to extract larger

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<sup>8</sup> Our recommendation treatments might raise the question of the experimenter demand effect (EDE) which refers to changes in behavior by experimental participants due to cues about what constitutes appropriate behavior. This is true especially when the information or advice that the players receive comes directly from the experimenter who has authority over the participants through his expertise and authority (Zizzo, 2010). In our case, the EDE would fall under the category of social EDE. This denomination describes a situation in which participants are encouraged to orient their decision in a specific direction because of an information or a clue having been communicated to them and exerting a form of social pressure. This effect is not problematic in our case, since the equivalent recommendations in a real situation would come from a government, which also has a form of authority over people. Indeed, as mentioned by Zizzo (2010), advising participants in a position of authority that reproduces a real-world setting, where the same type of authority applies, is one of the setups where EDE is justified by external validity purposes.

<sup>9</sup> See exact wording in Appendix A, for example: "The remaining trees will breed and increase their population by 5% for the next generation."

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4 400 quantities of resources when the recommendation on the sustainable amount of resource to extract  
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6 401 is not provided.

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11 404 **5. Experimental procedures**

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14 405 As described in the previous section, participants were recruited during the 2015 edition of  
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16 406 the "European Researchers' Night" in France (see Table 1 for details on the 11 participating  
17  
18 407 locations, plus the control laboratory sessions). The event offers activities and presentations,  
19  
20 408 animated by local scientists from all disciplines. As reported in Loheac et al. (2017), participants  
21  
22 409 to such events are fairly representatives of the national population, in terms of age, education, life  
23  
24 410 choices and sensibilities. The event is popular in all respects and does not suffer from selection  
25  
26 411 biases. It may however be argued that our participants are intrinsically more motivated by science  
27  
28 412 and learning than the general population. They could therefore exhibit a cooperative bias in their  
29  
30 413 behavior in the game. To address such a potential bias, we run controlled lab sessions involving  
31  
32 414 standard participants (students) in the Strasbourg sub-sample. While such strategy offers a high  
33  
34 415 level of control over treatments, it can provide a perfect control treatment on the specific age range,  
35  
36 416 as the students are not representative of the general population. The comparison between the  
37  
38 417 control sample and the overall general sample will be however informative and useful to detect  
39  
40 418 eventual behavioral biases. Imagine that the participants to the European Researchers' Night are  
41  
42 419 not representative, because a selection bias occurred in favor of citizens that have a better  
43  
44 420 understanding of the problem and a more critical view about the issue of resource depletion. Such  
45  
46 421 type of individuals could be seen as the "behavioral change leaders" in the population. If those  
47  
48 422 individuals react to our treatments, the outcome could be considered as a stress test measure of  
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50 423 what could happen in a wider "standard population".

51  
52 424 The common pool experiment was advertised as such an event, and visitors in the  
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54 425 participating cities could register for participation. Experimental sessions were organized at  
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56 426 intervals, throughout the evening of the researchers' night (from 7:00 PM till 10:30 PM).  
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58 427 Depending on local space constraints, participants either had to pre-register or could show up on a  
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60 428 first-come-first-serve basis. The experiment took place in lecture halls, seminar rooms and outdoor  
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430 order of the steps in the experiment).

431 Particular attention was paid to the understanding of instructions. As sessions varied in size,  
432 numerous research assistants and event volunteers helped during the experiment (the total team of  
433 experimenters was composed of more than 30 people, and at each location, the European  
434 Researchers' Night crew was very large, and many volunteers helped on each specific event). To  
435 make results comparable to the existing literature on laboratory experiments, we conducted  
436 controlled laboratory sessions in an experimental economics laboratory in one city (Strasbourg).  
437 Methods and incentives were identical. However, participants in the lab experiment were recruited  
438 from the regular subject pool of the experimental economics laboratory. This lab experiment  
439 produced homogenous results in all respects. All results are reported and compared in Appendix<sup>10</sup>.

City	Participants	Observations	Obs. >= 10years old	Average age	Percentage of women
Angers	207	202	194	32.9	52.1%
Besançon	224	221	218	28.5	58.7%
Bordeaux	303	273	268	23.6	58.2%
Brest	726	698	661	27.4	58.7 %
Dijon	487	478	465	30.1	54.8%
Le Mans	123	122	121	35.3	47.9%
Limoges	122	122	122	24.9	37.7%
Lyon	168	165	158	28.9	58.2%
Metz	129	128	123	30.9	61.8%
Paris	126	117	115	31.5	46.1%
Toulouse	198	197	196	26.9	56.6%
<b>All</b>	<b>2813</b>	<b>2723</b>	<b>2641</b>	<b>28.6</b>	<b>55.4%</b>
Strasbourg	202	200	200	21.6	47.0%

440  
441 *Table 1: List of participating cities and number of participants and observations per city.*

442  
443 A total of 2813 subjects participated to all the steps of the experiment during the "European  
444 Researchers' Night" (see Table 1 for details). 2723 answered to the four questions (extractions at  
445 local and national level, age and gender). 82 participants were under 10 years old. We decided to

60 <sup>10</sup> All data and results available on request.

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4 446 exclude them as they were likely to misunderstand the instructions. The final sample consists  
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6 447 therefore of 2641 participants (94%). 202 subjects participated (200 fully observed) in the same  
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8 448 experiment in a laboratory in Strasbourg (see Table 1). The lab sample is younger than the field  
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10 449 sample and has less women. Treatments were randomly distributed across sessions (see Table 2 for  
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12 450 numbers of valid observations per treatment). As discussed above, the between subject treatment  
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14 451 variations concerned the recovery rate of the resource (*High* or *Low*) and availability of  
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16 452 recommendation on sustainable extraction levels (*Recommendation* or *No Recommendation*).  
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18 453

19 454 Due to the large variance of individual characteristics of participants and the possibly limited  
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21 455 attention span during the event, instructions were kept simple and followed the step-by-step  
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23 456 procedure outlined in Appendix A and were presented in a visual easily accessible form (see  
24  
25 457 Appendix A for the decision sheet). Specifically, we illustrated the two types of common pool  
26  
27 458 resources with actual resources characterized by either low or high recovery rates. The common  
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29 459 pool resources game was framed with the problem of fishing (high recovery rate), and the  
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31 460 extraction of trees (low recovery rate). Each participant responded to a question concerning  
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33 461 extraction at both the local and the national levels. Both questions were presented at the same time  
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35 462 (side by side on one sheet of paper) and participants could answer them in any order. Both the  
36  
37 463 *Local* and *National* treatment were framed with nature-related language: lake and wood in *Local*,  
38  
39 464 and sea and forest in *National*.

	<b>No Recommendation</b> on the sustainable extraction level	<b>Recommendation</b> on the sustainable extraction level
<b>Low</b> recovery rate: 5% Sustainable extraction level: 1 unit	<b>Local</b> N=745 [54] (10 participants per generation) <b>National</b> N=745 [54] (100 participants per generation)	<b>Local</b> N=574 [45] (10 participants per generation) <b>National</b> N=574 [45] (100 participants per generation)
<b>High</b> recovery rate: 15 % Sustainable extraction level: 3 units	<b>Local</b> N=717 [56] (10 participants per generation) <b>National</b> N=717 [56] (100 participants per generation)	<b>Local</b> N=605 [45] (10 participants per generation) <b>National</b> N=605 [45] (100 participants per generation)

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56 465 *Table 2: Treatments and numbers of observed participants by treatment across all 11 locations (Strasbourg*  
57 466 *into brackets)*  
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60 467 Participants were informed about the recovery rate of the resource (either *High* or *Low*), the  
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4 468 initial stock, and the number of other participants in a generation. Depending on the treatment  
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6 469 (*Recommendation* or *No Recommendation*), they were also informed about the sustainable  
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8 470 extraction level given the initial stock and the recovery rate (one unit in treatments with low  
9  
10 471 recovery rate, three units in treatments with high recovery rate).

11 472  
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13 473 Participants were asked to indicate their extraction level (between 0 and 5 resource units) for  
14  
15 474 the resource on both the local and national levels. They were informed that they would  
16  
17 475 simultaneously take part in this experiment with participants from other French cities and were  
18  
19 476 aware of the list of participating cities.

20 477  
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22 478 To determine outcomes, participants were randomly placed in generations containing 100  
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24 479 individuals from all eleven cities (*National level*) or 10 individuals from their own city (*Local level*)  
25  
26 480 at the end of the experiment. Instructions clearly specified that several succeeding generations  
27  
28 481 exist, but participants could not know in advance to which generation they would belong. They  
29  
30 482 were simply informed that other generations could be playing before or after them. To determine  
31  
32 483 final payoffs, participants were attributed randomly to a generation, and individual extractions were  
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34 484 implemented given that randomly determined order for participants. Participants from first  
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36 485 generations were able to extract the desired amount, until the resource was depleted. Once the  
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38 486 resource was exhausted, participants from the following generations received nothing. Moreover,  
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40 487 participants were randomly assigned a rank in their generation. In the case where current resource  
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42 488 availability was not sufficient to implement all extraction choices of a given period, the rank  
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44 489 determined priority of extraction. Participants were not aware of their individual rank.

45 490  
46 491 The gain from the extracted units were transformed into lottery tickets (one lottery ticket by  
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48 492 extracted unit) that allowed participants to gain one of 300 gift cards (value 10 euro). Therefore, in  
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50 493 this sense, monetary outcomes were incentive compatible as related to decisions: the more you  
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52 494 extract, the more lottery tickets you can have, so more chances to get the 10 euros card: final  
53  
54 495 monetary earnings affect decisions<sup>11</sup>. Participants were informed that computations would be  
55  
56 496 realized after the last session of the evening, and they would be informed of their actual rank, their  
57  
58 497 earnings and their participation in the lottery. The winners of the lottery received their 10 euros gift

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61 <sup>11</sup> Please note that no show-up fees were used in this experiment, nor in the lab or the field.  
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498 cards.

## 6. Results

A total of 2813 individuals participated in one of the sessions across the 11 different participating cities. The condition to participate to the incentive system (lottery) was to answer the four questions (local extraction, national extraction, age and gender). 2723 participants (96.8%) gave full answers. After excluding those that were less than 10 years old, the sample consists in 2641 subjects (93.9% of the participants). 55.4% are women and the average age is 28.6 years. Figure 1 reports the distribution of extractions across all treatments.

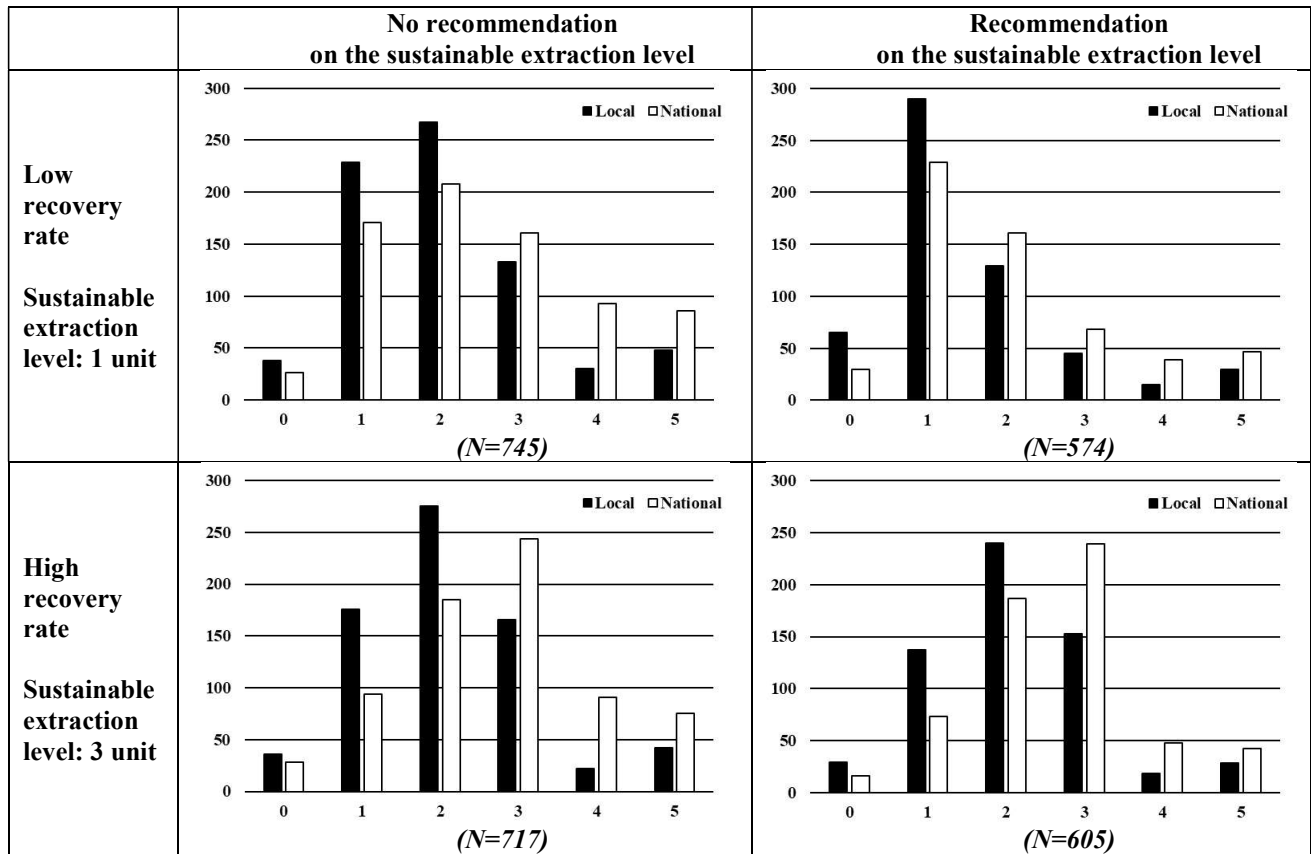


Figure 1. Number of observations by level of extraction for each treatment: low (upper graphs) and high (lower graphs) recovery rates, and without (left graphs) and with (right graphs) recommendation on the sustainable extraction rate.

When the recovery rate is high (Figure 1, bottom panel), participants extract on average 2.38 units of resources (n=2644), which is lower than the socially sustainable extraction of 3 units

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4 514 (Kolmogorov Smirnov:  $p < 0.001$ ; Wilcoxon signed-rank test:  $z = -24.454$ ,  $p < 0.001$ )<sup>12</sup>. However,  
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6 515 when the recovery rate is low (Figure 1, top panel), participants extract on average 2.06 units  
7  
8 516 ( $n = 2638$ ), which is significantly higher than the socially sustainable extraction of 1 unit  
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10 517 (Kolmogorov Smirnov:  $p < 0.001$ ; Wilcoxon signed-rank test:  $z = 34.413$ ,  $p < 0.001$ ). By comparing  
11  
12 518 the two distributions (low versus high recovery rate), we found that the extraction of the low  
13  
14 519 recovery rate resource is significantly lower than the extraction of the high recovery rate resource  
15  
16 520 (Kolmogorov-Smirnov:  $p < 0.001$ ; Two-sample Wilcoxon rank-sum (Mann-Whitney) test:  
17  
18 521  $z = 12.056$ ,  $p < 0.001$ ).  
19 522

20  
21 523 We find that the extraction of resources is significantly lower at the local level (1.98) as  
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23 524 compared to the national level (2.47;  $n = 2641$ ; Wilcoxon signed-rank test:  $z = -23.125$ ,  $p < 0.001$ ). We  
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25 525 further observe that at the individual level, 45.0% of individuals do not change extraction decisions  
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27 526 between the local and national resources (1188 out of 2641). There are two explanations of the  
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29 527 proportion of 45% of individuals who do not change their extraction between the local and the  
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31 528 national scales. The first one is purely statistical: most of those who do not vary are people who  
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33 529 extract the sustainable levels (1 and 3). Those levels are the same at the local and national scales.  
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35 530 Previous results suggest that more altruistic and cooperative participants in social dilemmas have  
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37 531 more stable choices when confronted to new uncertainty sources (e.g., national vs. local scale),  
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39 532 compared to individualistic and competitive participants (De Kwaadsteniet et al., 2006). The second  
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41 533 explanation of the 45% of individuals who do not change their extraction between the local and the  
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43 534 national levels could lie in the status quo, superposed to an early activation of the group identity,  
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45 535 the “we-intentionality” explained earlier. This happens, again, for those who already activated the  
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47 536 sustainable extraction levels. Status quo appears in many experiments in sequential decision  
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49 537 making. Here in the local treatment the team reasoning is activated, and some people may keep it  
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51 538 when required to move to the national level. As we measure effects of the local vs. national scale  
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53 539 not in isolation, but combined with the recovery rate and the information, the reduction in the  
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55 540 psychological distance from the recovery rates and information availability may overcome the  
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57 541 expected increase in the psychological distance when moving to the national level. Another 44.3%  
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59 542 of individuals (1170 out of 2641) increase their extraction level when moving from the local to the  
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61 543 national resource, and finally 10.7% of individuals (283 out of 2641) decrease their extraction. We

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<sup>12</sup> For each comparison, we present a parametric and a non-parametric test.

see on the borders of the distributions in Table 1 that the extractions are higher at the national level for the high values (4 and 5), and the opposite happens for the low values. However, the 44.3% who increase their extraction more than compensate the status quo since overall, the difference is significant. On the whole sample, women (2.08) extract significantly less than men (2.40; Kolmogorov-Smirnov:  $p < 0.001$ ; Mann-Whitney:  $z = 8.743$ ,  $p < 0.001$ ). Men extract significantly less at the local level than at the national level, but their reduction is significantly higher as shown in Figure 2 (-0.53 instead of -0.44; Kolmogorov-Smirnov:  $p < 0.01$ ; Mann-Whitney:  $z = 2.732$ ,  $p < 0.01$ ).

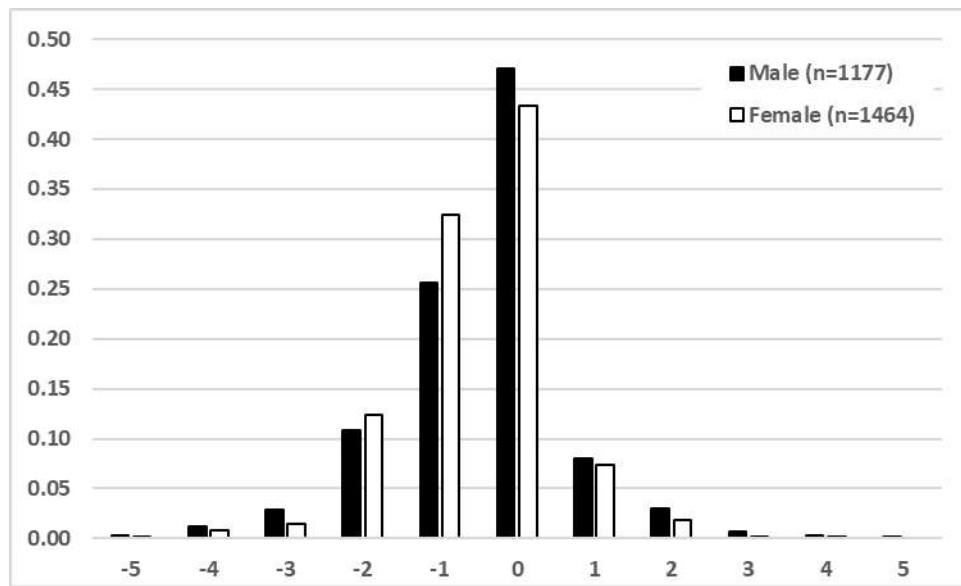


Figure 2. Percentages of changes in extraction decisions from local to national resource (negative values imply an increase in extractions at national level), by gender (all treatments)

Descriptive statistics show that extractions are lower when a recommendation about the sustainable level of extraction is provided. Specifically, extraction levels without recommendation are 2.28 (Low) and 2.41 (High), respectively. When a recommendation is given, these numbers decrease to 1.77 (Low, Kolmogorov Smirnov:  $D = 0.2234$ ,  $p < 0.001$ ; Mann-Whitney test:  $z = 11.213$ ,  $p < 0.001$ ) and 2.36 (High, Kolmogorov Smirnov:  $D = 0.0480$ ,  $p = 0.097$ ; Mann-Whitney test:  $z = 0.660$ ,  $p = 0.5094$ ), respectively. When the recovery rate is high, there is no significant impact of the recommendation, because the extraction is already below the sustainable rate without recommendation. When the recovery rate is low, in absence of the recommendation, the extraction

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4 565 levels are significantly higher than in presence of the recommendation. Hence, the recommendation  
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6 566 is more effective in this treatment.  
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10 568 To substantiate these descriptive statistics, we present an econometric analysis in which the  
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12 569 extraction level is the dependent variable. We present results from multilevel linear regressions,  
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14 570 allowing for observations being nested by individuals (2641) which are nested in sessions (67)<sup>13</sup>.  
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16 571 Likelihood ratio tests support the use of the three-level model (Model 1: Chi2(2)=1250.39,  
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18 572 p<0.001; always significant for models 2 and 3)<sup>14</sup>. Table 3 presents the results. Model 1 of table 3  
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20 573 reports estimates of the treatment dummy variables alone. Model 2 of table 3 reports estimates  
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22 574 including the age and gender of the participant in the estimation. Model 3 of table 3 reports  
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24 575 estimates including interaction variables. More specifically, it distinguishes the effect of the  
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26 576 recommendation in treatments with high and low recovery rates, as well as the effect of the national  
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28 577 treatment, according to the gender and age of the participant. We compare these field results with  
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30 578 the lab results (from data collected in Strasbourg) at the end of the section (they are presented in  
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32 579 appendix B, table B1).  
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	Model 1			Model 2			Model 3		
	Coefficient		Standard Error	Coefficient		Standard Error	Coefficient		Standard Error
National	0.490	***	(0.021)	0.490	***	(0.021)	0.619	***	(0.051)
Low rate	-0.333	***	(0.042)	-0.325	***	(0.041)	-0.130	**	(0.055)
Recommendation	-0.297	***	(0.063)	-0.285	***	(0.056)	-0.068		(0.069)
Age				-0.010	***	(0.001)	-0.007	***	(0.001)
Female				-0.293	***	(0.042)	-0.334	***	(0.046)
Recommendation *Low							-0.437	***	(0.083)
Female*National							0.087	**	(0.042)
National*Age							-0.006	***	(0.001)

13 We present results from a linear model, since STATA assumes linearity for a larger number (6) of levels. We present results from multilevel mixed-effects ordered logistic regression as robustness checks in the Appendix (see Table A2).

14 Four-level models were also considered including the location (city) as an additional nest. Likelihood ratio tests did not support the use of the location as a fourth level of clustering for the three models presented in table 2.

Constant	2.281	***	(0.048)	2.732	***	(0.064)	2.564	***	(0.071)
Wald chi2 (df)	(3) 629.80***			(5) 737.62***			(8) 794.18***		
N	5282			5282			5282		

Table 3. Three level multilevel linear regressions predicting individual extraction levels. Including random effects for sessions (67) and individual ID (2641) (\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ )

Model 1 replicates the descriptive statistics presented before. Specifically:

*Result 1. Participants extract more units of the resource at the national level than at the local level.*

The difference in extraction levels is highly significant ( $p < 0.001$ ). The effect of extracting from a national resource available to a large group is important, with a coefficient of 0.49. Thus, individuals extract on average half a unit more (where up to five units of extraction are permitted) when moving from a local resource to a national resource. This result is in line with the first hypothesis.

*Result 2. When the recovery rate is low, participants extract fewer units from the resource.*

The impact of the low recovery rate is highly significant ( $p < 0.001$ ), corresponding to 0.33 units less than for the high recovery rate. This is not surprising and is consistent with the second hypothesis. Participants do not seek to extract a predefined quantity, but rather adapt their extraction to leave the possibility to participants from the following generations to have access to the resource.

*Result 3. Participants who received a recommendation about the sustainable extraction rate extract less.*

When the efficient extraction level is explicitly mentioned to the participants, their extraction rate decreases by 0.29 units on average (significant at  $p < 0.001$ ). However, as expected, this result is mainly driven by the treatment where the recovery rate of the resource is low (Table 3, Model 3). In this case participants reduce their extraction by 0.44 points on average. When the resource



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4 611 recovery rate is high, the recommendation has no significant effect on the extracted quantity. A  
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6 612 plausible reason is that the extraction rate is already below the sustainability level without the  
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8 613 recommendation.

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10 614 Models 2 and 3 present results when additional individual characteristics are included.  
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12 615 Results show that older participants extract significantly less resources ( $p < 0.001$ ). All things being  
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14 616 equal, older participants also extract less resources at the national level ( $p < 0.001$ ). Regarding  
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16 617 gender, we show that women extract fewer resources on average ( $p < 0.001$ ). Model 3 further shows  
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18 618 that the increase in extraction from local to national is more important among female participants  
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20 619 ( $p < 0.05$ ), as was already suggested in Figure 2. For example, if we consider the treatment in which  
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22 620 the recovery rate is high and the participants do not have a recommendation, model 2 predicts that  
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24 621 there are 30 years between men and women for the same level of extraction (a 70-years old man  
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26 622 extracted 2 units at local level, as 40-years old woman; or a 20-years old woman extracted 2.2 units  
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28 623 at local level, as a 50-years old man).

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30 625 Finally, we compare the results from the general population to those from our control sessions  
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32 626 under standard laboratory conditions (see Table B1 in Appendix B). Note that, as usual in lab  
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34 627 experiments, in ours, a younger population (students aged 19 to 35, 21 old on average as reported  
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36 628 in Table 1, 47% of women) participated in our sessions. We observe a large and significant resource  
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38 629 scale effect in the lab (i.e. National versus Local), consistent with what we observe in the general  
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40 630 population. The results concerning the recovery rate (Low versus High) and the provision of the  
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42 631 recommendation about sustainability (Recommendation versus No Recommendation) are  
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44 632 qualitatively similar though the coefficients do not reach significance, most likely due to a lack of  
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46 633 statistical power. A low rate has a significant negative impact when considering individual  
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48 634 characteristics. With respect to individual characteristics, we observe a significant and large effect  
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50 635 of being a woman, in line with the results from the general population. We observe no significant  
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52 636 age effect, which is not surprising given the restricted age range of the laboratory participants (ages  
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54 637 between 19 and 35).

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56 639 Our main findings, i.e. that extraction is higher in games played on a national level (with  
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58 640 larger groups) rather than a local one (with smaller groups), that the recovery rate influences  
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60 641 extraction and that recommendations matter—are all similar to findings from earlier studies on  
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4 642 games involving cooperation. As noted, earlier studies have shown that group size matters for  
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6 643 extraction, that social distance matters for cooperation. However, to our knowledge, none of the  
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8 644 previous papers examined i) all these features combined and ii) within a large-scale experiment,  
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10 645 iii) with a pedagogical and popularization purpose towards a broad sample of participants, iv) by  
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12 646 the means of an innovative hybrid experiment. These combined elements are of crucial importance  
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14 647 with regard to the ability of experiments to inform decision making in everyday life.  
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17 649 Our results in particular validate the specific choice of our design. Unlike standard dynamic  
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19 650 or generation games, our design allow participants to decide on an extraction level as part of a  
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21 651 generation, without knowing how much was extracted previously, which mimics many real-life  
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23 652 situations for which no clear information is available to individuals. In a standard experiment,  
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25 653 participants in a later generation would extract different amounts if they observed that previous  
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27 654 generations had extracted little vs. a lot. Our design makes all participants blind to the history at  
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29 655 their generation, creating a hybrid between a one-shot and a dynamic game. This allows  
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31 656 participants to reveal their intrinsic preferences for the extraction and behave as in real life. Our  
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33 657 results are coherent with those reported in Ajdukovic et al. (2019), in which our design was partly  
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35 658 reproduced several years later.  
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39 660 Result 1 confirms that as group size and social distance increase, extraction levels move in  
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41 661 the same direction. This finding supports Olson (1965)'s conjecture as well the evidence of  
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43 662 experimental social dilemmas (Brewer and Kramer, 1986; Bohnet and Frey, 1999; Boone et al.,  
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45 663 2008). Although this result was expected for a social dilemma involving rivalry, we also found the  
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47 664 pedagogical environment in which the experiment took place does not prevent such group size  
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49 665 effect. This is however positive, in the sense that the potential selection of intrinsically motivated  
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51 666 individuals attending a scientific event does not seem to interfere with the revelation of their  
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53 667 preferences, but also casts doubt whether pedagogical environments can foster more cooperation  
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55 668 through shared identities with other remote participants.  
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59 670 Similarly, our Result 2 reveals that participants abstain from higher extraction levels when  
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61 671 the recovery rate is low. This finding contradicts the previous evidence reported by Fischer et al.  
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63 672 (2004). In their intergenerational common pool resource game, although some restraint is observed,  
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673 they do not find differences in extraction levels between having a high or a low resource’s growth  
674 rate, and a lack of cooperation is accentuated when participants are aware of the intergenerational  
675 link in the condition with low recovery rate. Hence, the participants in our experiment seem to be  
676 more aware of the different generations in our setting. We speculate that, as the differences in  
677 recovery rates are connected to physical properties of the resource (i.e., fish and trees), the  
678 pedagogical environment is more useful in this case to create awareness and leave resources for  
679 upcoming generations.

680  
681           However, one important point to be discussed is the fact that participants do extract less in  
682 the low recovery rate case, while still extracting in this same case more than the sustainable level.  
683 This result is not, on the one side, attributed to a focal point bias. On the other side, this result can  
684 be attributed to a psychological distance bias. Indeed, in our design, participants could extract  
685 between 0 and 5 units. This gives a strategy range of 6 points with no clear middle focal point. This  
686 strategy space was selected on purpose, as to be sure that participants will not be attracted to a focal  
687 point (as demonstrated for Likert scales, for example). In the previous literature, there is no  
688 evidence that such a strategy space would induce any focal point attraction. Moreover, we do have  
689 significant differences between treatments and impact of the treatment variation, which pushes us  
690 to believe there is no focal point bias here. What is proved in the previous literature is, on the  
691 contrary, that 0 and 5 could constitute focal attraction points. In Hauser and al. (2014) for instance,  
692 in a quite close context to our design, it is shown that an intergenerational common resource is  
693 almost always immediately destroyed by anonymous individuals, even when they are informed that  
694 other individuals depend on its protection (the attraction of extracting everything possible, here 5).  
695 This does not happen in our design, which proves that our treatment variation worked and that  
696 individuals are sensitive to the size of the group, the local vs. the national scale of the resource and  
697 the recovery rate. However, it is indeed puzzling to see that when the recovery rate is lower, they  
698 extract less than when the recovery rate is higher, while both extractions are included in the interval  
699 [1,3] formed by the two sustainable levels. Does this make them less cooperative?<sup>15</sup> One  
700 counterargument could explain this behavior: the low recovery rate makes reference to a tree: not

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<sup>15</sup> Extractions without recommendation: Fish: 83.96% extract 0 to 3 units, the recovery rate; Tree: 31.14% extract 0 to 1 units, the recovery rate; With recommendation: Fish: 88.76% extract 0 to 3 units, the recovery rate; Tree: 53.48% extract 0 to 1 units, the recovery rate.

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4 701 only the recovery rate is lower, but also the actual regrow is slower. This may induce people to  
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6 702 increase the psychological distance between them and the consequences of their action: I can cut a  
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8 703 tree now, but it is likely it will not grow during my generation, and also, during my generation, I  
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10 704 will not see the negative impact of my action. This increased psychological distance can push  
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12 705 individuals to increase their extraction as they feel less connected to the dilemma: the abstract  
13 706 nature of long-term environmental consequences situated farther in the future increase the  
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15 707 psychological distance, individuals feel more indifferent to events perceived as "farther away"  
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17 708 (Trope and Liberman, 2018). The other explanation is purely statistical: at the inspection of Table  
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19 709 1 you can notice that there the first two modes overall are not around 2 and 3 for the low recovery  
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21 710 cases; the modes are at 1, with the recommendation, and 1 is the second most chosen value even in  
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23 711 the absence of recommendation. Moreover, there is heterogeneity in the data hence the average,  
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25 712 and it doesn't correspond to a focal point.  
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28 714 Finally, our Result 3 confirms that participants tend to follow the recommendations, leading  
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30 715 to lower extraction levels. This finding goes in line with existing results from linear public  
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32 716 goods games (Chaudhuri et al., 2006; Chaudhuri and Paichayontvijit, 2017), while goes against the  
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34 717 results from non-linear common pool resource games (Mantilla, 2015). Building again the  
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36 718 connection with the pedagogical environment, it is plausible that our setting favored the use of  
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38 719 recommendations as a coordination device yielding better social outcomes.  
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## 41 721 **7. Discussion and conclusion**

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44 723 The experiment we developed in this paper focuses on individual extraction behaviors in the  
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46 724 context of a common pool resource available at local and national level. Our design has several  
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48 725 particularities. The experimental sessions were carried out simultaneously in 11 French cities, thus  
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50 726 allowing us to form groups of participants at the local and national levels. This change in scale  
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52 727 (local versus national) induces both a change in the number of participants sharing the same  
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54 728 resource, as well as a variation in the geographic proximity of the participants sharing the resource.  
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56 729 While the experimental literature has previously studied the effect of the size of a common pool  
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58 730 and of social distance to other group members separately, the two dimensions have not yet been  
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731 studied in combination. However, comparing local and national common pool resources problems  
732 implies a simultaneous and realistic variation of the two dimensions.

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734 In our experiment, participants were split into different generations, which had access to a  
735 common pool resource. National groups were randomly composed of participants from all the cities  
736 in which the experiment was implemented, while local groups involved only participants from the  
737 same city. When making their choice, participants did not know which generation they belonged  
738 to. This design twist allowed us, among other things, to introduce dynamics in a one-shot game. In  
739 addition, depending on the treatment, participants had access to a resource with a high or a low  
740 reproduction rate, as well as to a recommendation about the sustainable level of extraction.

741  
742 We find that the participants choose to extract a significantly higher quantity of resource at  
743 the national level than at the local level. This is true for all participants and is even more significant  
744 for women. This is in line with previous results showing that women are more sensitive to local  
745 environmental problems (Blocker and Eckberg, 1989; Mohai, 1992). Our results also show that,  
746 depending on the recovery rates, the recommendation regarding the sustainable level of extraction  
747 might or might not influence extraction. In our setting, extractions were only reduced when the  
748 recovery rate of the resource was low, but do not reach the recommendation level (the commons  
749 tragedy is just slowed down). When the recovery rate is high, there is no effect of the  
750 recommendation because the extraction is already under the sustainable level even in the absence  
751 of a recommendation.

752  
753 If replicated and confirmed, these results have potentially important implications in terms of  
754 environmental public policies. Our results suggest that environmental policies involving common  
755 pool resources would have a greater impact by being divided at smaller scales rather than being  
756 defined at a global scale. For example, the use of Territorial Use Rights Fisheries -TURFS, dividing  
757 larger fishing areas into smaller units, as to ease collective decision-making among fishermen, have  
758 shown to improve the management of common resources in Japan (Cancino et al., 2007; Uchida  
759 and Makino, 2008). Our results also show that precise scientific data on the availability of a  
760 resource will only have a significant effect if the recovery rate of the resource is relatively low.  
761 This result potentially calls into question the effectiveness of communication campaigns aimed at

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762 limiting the consumption of resources (e.g. water), which are currently still available in large  
763 quantities, but whose availability remains uncertain in the future.

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765         Naturally, our study also has several limitations. Although the design of this experiment  
766 allowed us to collect a large amount of data on people aged 10 to 91, the people who took part in  
767 this experiment are mostly city dwellers who are curious about academic research. It is therefore  
768 possible that the participants to this experiment have a more developed knowledge of  
769 environmental problems and an ecological awareness than the average population. However, the  
770 European Researchers' Night is known to attract people from many socio-demographic clusters,  
771 and it is not considered as an elite intellectual gathering, but as a popular and diverse event.  
772 Furthermore, due to the nature of our experiment and the diverse population that participates in the  
773 European Researcher's Night, we opted for a framed experiment, in which resources were  
774 described as fish and trees. We believe it would be interesting to replicate this study using a neutral  
775 context in which the nature of the resource is not specified, in order to check if the framing we used  
776 had an impact on the choice of participants.

777  
778         The realization of this experiment allowed us, in addition to the classical academic part, to  
779 immerse ourselves in an experiment of scientific popularization. This allowed us to make the  
780 transition from the production of experimental data to the description of this process. This  
781 transition implies taking into account Collins' (1985) criticism that this is only possible when,  
782 explicitly, the distinction can be made between a "good" and a "bad" experiment. This distinction  
783 must be credible and internalized both by researchers, in the construction of the design, but also by  
784 the public, who must understand our choices. In experimental economics, several norms and  
785 practices unanimously accepted by the community exist: the rule of no-deception, the existence of  
786 incentives, the common knowledge of instructions, etc. This facilitates the task in terms of sharing  
787 and explaining the procedures but forces us to make choices. The exercise was situated at the  
788 crossroads of multiple ambitions (to build a valid design, to collect scientifically usable data, to  
789 popularize the method, to empower the public, etc.) and of logistical, methodological, and  
790 institutional constraints. We have therefore undertaken efforts to explain how we reconciled them  
791 and made choices. Our purpose was educative (yet not instructive), in the sense that we confronted  
792 individuals with a social dilemma. Therefore, we did not test per se that people are learning,

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4 793 however, there are numerous results as reported in Loheac et al. 2017 or Eber et Willinger (2012)  
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6 794 that people are learning while they participate into experiments and debriefs.  
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10 796 Beyond this popularization effort, this experiment allowed us, on the one hand, to question  
11 797 the relative importance of the principles of experimental economics: should we privilege, if choices  
12 798 are to be made, the neutrality of the context, the monetary incentives, the control, the non-deception  
13 799 principle? Indeed, Guala (2005) specifies that experimental knowledge is constructed, and that it  
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15 800 is the result of rules and conventions that must be reproduced, regardless of the experimental  
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17 801 setting. For example, Friedman and Sunder (1994) state that experimental economics uses data  
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19 802 created under controlled conditions. Control is thus one of the strong constraints to be fulfilled  
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21 803 when the laboratory is moved to a scientific mediation event. With a clever design, we managed to  
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23 804 keep all these principles in our design, and only relaxed the neutrality of the context, without  
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25 805 introducing an experimental demand bias (because the situation evoked corresponds to a situation  
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27 806 very close to real decision making). On the other hand, this design was not only a source of  
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29 807 constraints, but also of opportunities. Indeed, we were able to explore a generational protocol that  
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31 808 was not easily achievable in the laboratory, a situation of uncertainty about the place of the  
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33 809 individual within a generation and of this generation over time, as well as the real distinction by  
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35 810 city and by local-national resource. Finally, we were able to collect a record number of data (more  
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37 811 than 2700 participants) in a few hours.  
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41 813 In addition, our experiment emphasizes that, in a context of scarce resources, the examination  
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43 814 of the potential offered by the mobilization of the "behavioral capital" of individuals can be an  
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45 815 effective tool to improve the understanding of the resistance of individuals to change, particularly  
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47 816 in order to promote the ecological transition. We have introduced examples of behavioral levers  
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49 817 that can be activated to overcome this resistance and lead to sustainable behavioral changes. For  
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51 818 this, we have taken up the definition of environmental use and preservation from Milfont and  
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53 819 Duckitt (2010), according to which "environmental preservation expresses the general belief that  
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55 820 priority should be given to protecting nature and the diversity of animal species in their natural  
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57 821 state, and preserving them from human use and alteration", while using the environment expresses  
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59 822 "the general belief that it is normal, appropriate and necessary for nature, and all natural phenomena  
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61 823 and species to be used and altered to meet human objectives." This allowed us to discuss eco-  
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4 824 behavior with the audience, to exchange about collective and personal interests, a "reasonable"  
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6 825 exploitation of the environment. The sustainability of resources must be ensured in the long term,  
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8 826 while by overexploiting the environment, the individual "not only diminishes the opportunities for  
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10 827 other individuals to obtain a reasonable share of resources, but also impacts the capacity of the  
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12 828 environment to regenerate itself over the long term" (Adjukovic, 2015), and thus impinges on the  
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14 829 ability of future generations to draw down resources.

15 830 Finally, we discussed with participants the exploitation dilemma: while many resources are  
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17 831 common pools, no user can be deprived of their use, even if abused (e.g. wildlife, water resources,  
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19 832 clean air, etc.). This leads to the "tragedy of the commons" where human behavior is driven by the  
20  
21 833 maximization of individual gains and not by the desire to achieve a socially optimal solution. While  
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23 834 surveys confirm a widespread desire among the population to care for such resources, increasingly  
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25 835 alarming empirical shows overexploitation, some to a point of no return. We also highlighted the  
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27 836 gap between pro-environmental attitudes and real behavior, and explained that experimental  
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29 837 economics allows, through incentivized games, to differentiate between what people report and  
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31 838 what they do and thus avoid this reporting bias.

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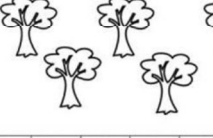
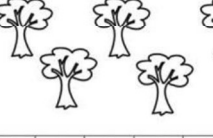
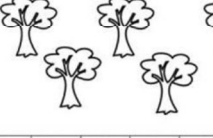
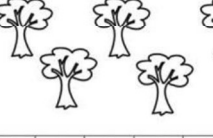


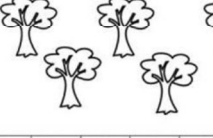
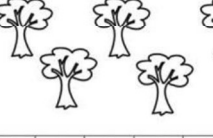
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## Appendix A

Poissons sans information - PSI	Arbres sans information - ASI																								
<b>Vous êtes un pêcheur</b>	<b>Vous êtes un bûcheron</b>																								
Et vous pouvez pêcher dans deux lieux différents :	Et vous pouvez couper des arbres dans deux lieux différents :																								
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">Un <b>lac</b> auquel seuls les 10 pêcheurs de votre ville ont accès, à chaque génération.</div> <div style="border: 1px solid black; padding: 5px;">La <b>mer</b> à laquelle les 100 pêcheurs du pays ont accès, à chaque génération.</div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">Un <b>bois</b> auquel seuls les 10 bûcherons de votre ville ont accès, à chaque génération.</div> <div style="border: 1px solid black; padding: 5px;">La <b>forêt</b> à laquelle les 100 bûcherons du pays ont accès, à chaque génération.</div>																								
<p>A chaque génération, un nombre fixe de pêcheurs ont accès au lac et à la mer. Il y a des générations avant vous et après vous. La génération à laquelle vous appartenez sera tirée au sort après la fin de la Grande Expérience.</p> <p>Le stock initial de poissons est fixé au début de la Grande Expérience. A chaque génération, chaque pêcheur peut pêcher entre 0 et 5 poissons dans chacun des deux lieux. Les poissons restants vont se reproduire et leur population augmente de 15% pour la génération suivante.</p>	<p>A chaque génération, un nombre fixe de bûcherons a accès au bois et à la forêt. Il y a des générations avant vous et après vous. La génération à laquelle vous appartenez sera tirée au sort après la fin de la Grande Expérience.</p> <p>Le stock initial d'arbres est fixé au début de la Grande Expérience. A chaque génération, chaque bûcheron peut couper entre 0 et 5 arbres dans chacun des deux lieux. Les arbres restants vont se reproduire et leur population augmente de 5% pour la génération suivante.</p>																								
<p>ENTOUREZ et/ou COCHEZ LE NOMBRE DE POISSONS QUE VOUS SOUHAITEZ PÊCHER DANS LE LAC ainsi QUE DANS LA MER</p>	<p>ENTOUREZ et/ou COCHEZ LE NOMBRE D'ARBRES QUE VOUS SOUHAITEZ COUPER DANS LE BOIS ainsi QUE DANS LA FORÊT</p>																								
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### Main elements of the instructions

#### Trees without information

You are a lumberjack. You can cut trees in two different locations: In a wood, for which only 10 lumberjacks of your city have access to, in each generation; In the huge forest, for which 100 lumberjacks of the country have access to, in each generation.

Each generation, a fixed number of lumberjacks have access to the wood and to the forest. Some generations are preceding you and some other are following you. The generation to which you belong to will be randomly determined at the end of the Great Experiment.

The initial stock of trees is set at the beginning of the Great Experiment. In each generation each lumberjack can cut between 0 and 5 trees in each of the locations. The remaining trees will breed and increase their population by 5% for the next generation.



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1127 Circle and/or tick the number of trees that you want to cut in the wood and in the forest.

1128 Wood: initial stock: 230 trees, number of lumberjacks per generation: 100, recovery rate of  
1129 trees per generation: 5%

1130 Forest: initial stock: 2300 trees, number of lumberjacks per generation: 10, recovery rate of  
1131 trees per generation: 5%

1132 In order to get your prize in case of success in the lottery, please answer the following  
1133 questions.

1134 Timeline of experiment

- 1 Welcome participants with distribution of simplified instructions, decision sheets and pencils

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- 2 Reading and careful explanation of the instructions presenting the context and the roles of the participants

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- 3 Explanation of the generation principle

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- 4 Description of the stocks available at the start of the experiment

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- 5 Description of the decisions to be taken

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- 6 Explanation of the reproduction of resources from one generation to the next

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- 7 Information on the sustainability rate

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- 8 Description and explanation of incentives

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- 9 Decision making by participants, post-experimental questionnaire and collection of decision sheets

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- 10 Information to participants on payments collection

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- 11 Exchange with researchers about the experimental method, the experiment, the tragedy of the commons, the economic predictions (without presenting the expected results of the experiment)

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- 12 Evacuation of the room

Appendix B: additional tables:

Table B1: Three level multilevel linear regressions predicting individual extraction levels for control participants (Strasbourg). Including random effects for session (4) and individual (200)

	Model 1			Model 2			Model 3		
	Coef.		S.E.	Coef.		S.E.	Coef.		S.E.
National	0.635	***	(0.078)	0.635	***	(0.078)	1.627	*	(0.947)
Low rate	-0.250		(0.171)	-0.349	**	(0.168)	-0.437	*	(0.227)
Recommendation	-0.283		(0.172)	-0.185		(0.176)	-0.280		(0.238)
Age				-0.037		(0.048)	-0.018		(0.053)
Female				-0.605	***	(0.170)	-0.555	***	(0.187)
Recommendation*Low							0.198		(0.336)
Female*National							-0.102		(0.156)
National*Age							-0.043		(0.043)
Constant	2.546	***	(0.148)	3.645	***	(1.053)	3.259	***	(1.169)
Wald chi2 (df)	(3) 70.86***			(5) 84.03***			(8) 86.24***		
N	400			400			400		

\*: p<0.1 ; \*\*: p<0.05 ; \*\*\*: p<0.01

Table B2: Three level mixed-effects ordered logistic regression predicting individual extraction levels. Including random effects for session (67) and individual (2641)

	Model 1			Model 2			Model 3		
	Coef.		S.E.	Coef.		S.E.	Coef.		S.E.
National	1.327	***	(0.060)	1.327	***	(0.060)	1.594	***	(0.139)
Low rate	-1.041	***	(0.118)	-1.018	***	(0.116)	-0.415	***	(0.154)
Recommendation	-0.836	***	(0.171)	-0.801	***	(0.153)	-0.133		(0.191)
Age				-0.027	***	(0.004)	-0.020	***	(0.004)
Female				-0.767	***	(0.117)	-0.911	***	(0.130)
Recommendation*Low							-1.369	***	(0.232)
Female*National							0.298	***	(0.111)
National*Age							-0.014	***	(0.003)
Wald chi2 (df)	(3) 550.87***			(5) 613.50***			(8) 652.47***		
N	5282			5282			5282		

\*: p<0.1 ; \*\*: p<0.05 ; \*\*\*: p<0.01