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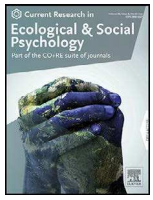

Motivational foundations of communication, voluntary cooperation, and self-governance in a common-pool resource dilemma

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ABSTRACT

Conventional wisdom (rational choice theory) assumes that individuals are destined to collectively destroy vital ecological systems due to their narrow self-interest. In contrast, Humanistic Rational Choice Theory (HRCT) assumes individuals can cooperatively self-govern, devising effective conservation agreements and governance systems to constrain self-interest for mutual benefit. To test this assumption, we examined the motivational, perceptual, and cooperative outcomes of communication in a resource dilemma experiment. HRCT assumes that poorly managed dilemmas undermine people's fundamental needs (e.g., procedural justice, security, equity), motivating them to self-govern. Groups that make decisions fairly (e.g., democratically) and enforce their agreements, should satisfy their collective needs better, ensuring better institutional acceptance and trust, thereby improving cooperation and sustainability. Small groups of four ($N = 41$ groups) harvested valuable resources from a shared pool without communication (Phase 1), with communication (Phase 2), and then without communication (Phase 3). Groups destroyed the resource and reported low need satisfaction during Phase 1. During Phase 2, most groups created governance systems, greatly improving their need satisfaction ($ds \geq 1.32$), trust ($d = 2.30$), cooperation and resource sustainability ($\eta^2 = 0.87$). Democratically governed groups reported the greatest need satisfaction, intrinsic motivation (i.e., institutional internalization and acceptance), and trust, especially if they primarily used positive social sanctions (e.g., praise) to enforce their agreements. Negative sanctions (e.g., shaming, threats) backfired, unless used in democratic groups. These factors accounted for 47% of the variance in Phase 3 voluntary cooperation and resource sustainability. Groups self-governed to collectively satisfy their interdependent fundamental needs.

1. Introduction

Conventional wisdom in the social and economic sciences (i.e., rational choice theory) assumes people cannot cooperatively solve societal dilemmas, such as the sustainable management and equitable distribution of vital resources, because they are too self-interested. They shirk responsibility and deceive one another for short-sighted personal gain (Hardin, 1968; Hobbes, 1651/1947). They do not create durable social contracts (e.g., cooperative agreements) or systems of governance for mutual benefit. People are trapped, destined to destroy the social and ecological systems they need for survival, unless a benevolent dictator intervenes, enforcing rules and compelling individuals to honor their agreements (Ostrom et al., 1992; cf. Miller, 1999).

Narrow self-interest undoubtedly contributes to cooperative failures. However, tragedy is not inevitable. Human civilization exists because fallible human beings *self-govern*. They create rules, norms, and governance systems that resolve societal conflicts, share vital resources, and provide necessary public goods (Ostrom, 1998, 2010a). People are also more cooperative than expected (Ostrom, 2010b). In some cases, they punish selfish individuals and seek equitable allocation of economic resources, even when doing so is costly or without direct personal benefit (Dawes et al., 2007; Fehr and Gächter, 2002; Rustagi et al., 2010). Elinor and Vincent Ostrom's (Ostrom, 1990, 1994, 2010a) seminal research on societal self-governance demonstrates that cooperative self-governance is facilitated by stakeholder communication, shared (democratic) decision making, and simple methods of monitoring and enforcing compliance (Cox et al., 2010; cf. Dietz et al., 2003). These factors represent important foundations ("design principles") for effective collective action in social-ecological dilemmas. However, their behavioral mechanisms are poorly understood (Agrawal and Ribot, 2014; Bowles, 2008; DeCaro, 2018, 2019).

Collective governance systems are based in *social contracts*—rules, norms, and agreements that coordinate action, build trust, and encour-

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age self-restraint (Gintis, 2000; Henrich et al., 2005; Ostrom, 1980, 2003). The scientific community does not adequately understand the central motivations and social cognitions that energize robust social contracts, or cooperative self-governance (DeCaro, 2019; Ostrom, 1998, 2010a; Parks et al., 2013). It is also unclear how fundamental aspects of governance, such as shared decision making and enforcement, influence these processes. This gap contributes to misguided public policies that undermine both human welfare and ecological sustainability. Hence, interventions widely believed to facilitate cooperation (e.g., public participation, decentralization, economic sanctions) more commonly yield mixed results (Chess and Purcell, 1999; Bowles, 2008; DeCaro et al., 2017a; Ostrom et al., 2007).

We address this issue by investigating the core motivations (e.g., fundamental needs, internalization) and social cognitions (e.g., legitimacy, acceptance, trust) that underlie self-interest and altruism and, therefore, drive cooperative self-governance. To observe self-governance, we placed participants in a resource dilemma experiment and allowed groups members to communicate after an initial phase without communication. We later removed communication to better observe voluntary cooperation and the robustness of groups' social contracts. We measured participants' motivations and perceptions, coded the content of their communication, and examined their group decision-making and enforcement (social sanction) processes. Participants decided for themselves how to interpret the situation and behave. Therefore, this design provides a strong test of individuals' motives for self-governance.

Our work is based on Elinor Ostrom's research (Ostrom, 1998, 2003, 2010b) and Humanistic Rational Choice Theory (HRCT). HRCT DeCaro (2018, 2019) is an integrative theory of motivation and decision making in social dilemmas. HRCT describes human cooperation as motivated by a desire to maintain basic social-psychological needs (e.g., DeCaro et al., 2015, 2020; DeCaro and Stokes, 2013; cf. Frey et al., 2004; Ryan and Deci, 2017a; Van Vugt, 2009). According to HRCT, the role of governance is to provide institutional supports for need satisfaction. In the current experiment, we placed individuals in a resource dilemma without any institutional support. We show that inability to communicate in a social-ecological dilemma (Phase 1) creates cooperative failure that undermines needs for self-determination, competence, fairness (equity, procedural justice), belonging, security, and economic welfare. However, we also show that, when given the opportunity to communicate (Phase 2), these deficits motivate individuals to create social contracts (conservation agreements) and cooperative governance systems, specifically to resolve the dilemma and collectively restore their fundamental needs. Groups that made their decisions more democratically and primarily used positive social sanctions (e.g., praise) to enforce their agreements accepted their agreements more, trusted one another more, and continued to cooperate and sustain the resource voluntarily after communication ended (Phase 3). Negative sanctions (e.g., warnings, threats) backfired, unless used in democratic groups.

We first summarize prior research on communication in social dilemmas. Afterward, we introduce HRCT and explain its predictions for the current research. By focusing on central motivations and social cognitions, this research develops a richer, more informative description of cooperative behavior in ecological dilemmas.

2. Communication

Stakeholder communication plays an integral role in effective governance of social-ecological systems (Ostrom, 1990, 2010a). Communication enables social learning, deliberation, and problem-solving (e.g., Gerlak and Heikkila, 2011; cf. Pahl-Wostl, 2009; Yu et al., 2016), which are the basis for the shared understanding and social contracts (e.g., conservation agreements) that underpin cooperative self-governance (Ostrom, 1980, 1990, 1994).

Many field studies and laboratory experiments find that communication improves cooperation (e.g., Dawes et al., 1977; Hackett et al., 1994; Janssen et al., 2010; Kerr and Kaufman-Gilliland, 1994; Orbell et al., 1988; Ostrom et al., 1992; Pavitt, 2011; cf. Balliet, 2010; Sally, 1995). For example, communication is essential in the case systems Elinor Ostrom and others have examined in forestry management, fisheries, water governance, and public good provision (Ostrom, 2010a; cf. Cox et al., 2010). Ostrom et al. (1992) replicated these dynamics in the lab, demonstrating that self-interested individuals can devise group decision-making procedures, agreements, and enforcement mechanisms to manage simple simulated public goods (public markets) and resource systems (see also, Hackett et al., 1994).

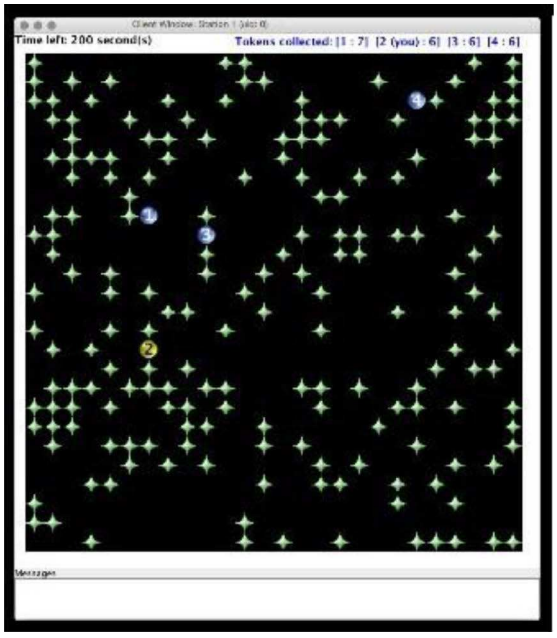

Fig. 1. Foraging Task Resource Dilemma. Star tokens are resource units ("plants"). Circles are participant avatars. Participants see their avatar in yellow (others are blue). Tokens collected by each person each round are displayed in the upper right corner. For example, this is Player 2's screen; this player has collected 6 tokens ("[2 (*you*), 6]").

Janssen et al. (2010) demonstrated these processes again using more complex and realistic ecological simulations (cf. Janssen, 2010; Yu et al., 2016). In the *foraging task* (Fig. 1), group members access a finite pool of tokens ("plants") worth $0.02 each, randomly distributed across a field. Each foraging period lasts four minutes, and the tokens regenerate based on local density. However, if group members harvest the tokens too quickly, the resource collapses, triggering ecological tragedy and reducing everyone's economic welfare. This experimental environment allows more complex, spatial and temporal resource management strategies, agreements (e.g., delayed harvests, private and communal property), and enforcement systems (e.g., shaming, collective punishment) to emerge. These institutional arrangements mirror those observed in field cases (Janssen et al., 2010; Ostrom, 2006). This format is also intuitive: participants observe defection and cooperation in real-time, deeply engaging their psychosocial processes and behavior (see also, DeCaro et al., 2015).

In experimental examples of robustly effective communication, the social contracts that emerge persist. These contracts encourage substantial voluntary cooperation and resource sustainability, without continued communication or enforcement (e.g., Hackett et al., 1994; Janssen et al., 2010; Ostrom et al., 1992; Yu et al., 2016). In real-world dilemmas, enforcement is often required to maintain long-term cooperation (Ostrom, 1990, 2010a; Ostrom et al., 1992). However, voluntary cooperation remains important, because most societal dilemmas are too complex (e.g., too many actors, private behaviors) to perfectly enforce. Voluntary cooperation smooths transaction costs and fills gaps in formal, external regulation (Bowles, 2008; DeCaro et al., 2015). Hence,

a balance is needed between external enforcement and internal self-regulation (Bowles, 2008; Frey et al., 2004; Ostrom, 2000; Sutinen and Kuperan, 1999).

Communication may improve cooperation via multiple mechanisms (Balliet, 2010; Ostrom, 2010b; Pavitt, 2011; Sally, 1995). Communication can facilitate information exchange, yielding better conservation strategies (Pahl-Wostl, 2009; Yu et al., 2016); facilitate group identity (e.g., self-other merging), increasing in-group altruism (De Cremer and Van Vugt, 1999; Orbell et al., 1988); and catalyze formation of positive reputations and trust (e.g., Bendtsen et al., 2016). These factors allow group members to form credible commitments (i.e., social contracts), which increase stakeholders' expectation that others will cooperate (Kerr and Kaufman-Gilliland, 1994; Orbell et al., 1988; Ostrom, 1980; Ostrom et al., 1992), thereby supporting virtuous cycles of reciprocal cooperation (cf. Bendtsen et al., 2016; Dawes et al., 1977; Gächter, 2007; Milinski et al., 2002; Ostrom, 2003; Rand et al., 2009,2014). In well-functioning governance systems, most individuals internalize and robustly accept important social contracts (Kerr and Kaufman-Gilliland, 1994; Kerr et al., 1997; Ostrom, 1980). Internalization intrinsically motivates cooperation (e.g., DeCaro et al., 2015; cf. Schafer, 1968), encouraging self-regulation and voluntary enforcement (e.g., social shaming, strong reciprocity, altruistic punishment; Fehr and Gächter, 2002; Gintis, 2000; Ostrom, 2000).

These explanations have not been adequately integrated with the central concept of self-interest, leaving unanswered questions about communication, human motivation, and decision making (Anderies et al., 2011; DeCaro, 2019). We use Humanistic Rational Choice Theory to provide insight into three fundamental questions: (1) what motivates self-interested individuals to self-govern, devising cooperative governance solutions to resolve resource dilemmas? (2) How does communication improve cooperation, and why do some social contracts fail? (3) How do groups enforce their contracts, ensuring robust, long-term commitment to group agreements, without undermining voluntary cooperation?

3.0. Humanistic rational choice theory

Humanistic Rational Choice Theory (HRCT; DeCaro, 2018, 2019) describes the psychosocial processes involved in cooperative self-governance by integrating and extending Elinor Ostrom's behavioral theory of collective action (Ostrom, 1998, 2003, 2010b) with Self-Determination Theory (Deci and Ryan, 2000) and other foundational perspectives on motivation and decision making (e.g., De Cremer and Tyler, 2005; Messick and Brewer, 1983; Parks et al., 2013; Van Lange et al., 2013). HRCT also seeks to explain how core components of governance systems (e.g., collective choice, enforcement) influence cooperative self-governance in different contexts (DeCaro and Stokes, 2013; DeCaro et al., 2017a). HRCT proposes that cooperative self-governance arises from three core psychosocial processes (Fig. 2): (1) fundamental need satisfaction (via good governance and institutional legitimacy), (2) institutional internalization and acceptance, and (3) group cohesion (self-other merging, trust; cf. De Cremer and Tyler, 2005; Frey et al., 2004; Ryan and Deci, 2017b; Tyler, 2006;). When these factors are achieved (legitimacy, acceptance, cohesion), a virtuous cycle of (conditional) cooperation can emerge, enabling self-governance (e.g., DeCaro et al., 2015). We describe each of these elements before addressing communication.

Governance systems influence cooperation by affecting fundamental needs, which influence institutional internalization and acceptance, and formation of group cohesion (e.g., trust). Collective choice systems that satisfy the needs for procedural justice and self-determination are perceived as legitimate, legitimizing group decisions and their enforcement. Legitimacy triggers intrinsically-motivated (i.e., internalized) rule acceptance, encouraging initial (conditional) cooperation, satisfying basic security needs and increasing group cohesion via self-other merging and trust. Acceptance and trust begin and sustain a virtuous cycle (feedback loop). Failure to ensure legitimacy decreases acceptance, etc., triggering a vicious cycle of need frustration and defection. Contextual factors and actors' worldviews/mental models (e.g., cultural/subjective definitions of "decision fairness") influence the interpretation and perceived appropriateness (i.e., psychosocial fit) of particular governance systems, altering institutional preferences, need satisfaction, and subsequent cooperation (Adapted: DeCaro, 2018).

Fig. 2 shows a version of HRCT adapted for the current experiment, which involves individuals who lack pre-existing social contracts, motivations, or relationships (e.g., trust) and, therefore, must develop these elements to govern the resource effectively. HRCT assumes that fundamental needs drive self-interest, and factors that promote cooperative self-governance do so by affecting fundamental needs and social cognitions (cf. Van Vugt, 2009). We first describe the motivational and social-cognitive components of cooperative self-governance. Afterward, we describe the governance structures hypothesized to optimally engage and mobilize these motivations and group cooperative processes.

3.1. Need satisfaction: institutional acceptance

Fundamental needs refer to evolved social-psychological (i.e., social, institutional) needs that are ubiquitous and essential to human well-being, fundamentally affecting human cognition and behavior in all life domains and cultures.[1] HRCT focuses on six core needs, based on prior research. *Procedural justice* refers to culturally appropriate, fair institutional decision-making processes (Colquitt, 2001; Tyler, 2006). *Self-Determination* refers to self-agency—a sense of choice, internal perceived locus of causality, and self-concordance (acting in accordance with one's core values/goals; Ryan and Deci, 2006; Sheldon and Elliot, 1998;). *Security* refers to predictability, order, and safety (Hobbes, 1651/1947; Sheldon et al., 2001). *Competence, belonging,* and *equity* refer to efficacy and understanding (Bandura, 2010; Deci and Ryan, 2000); social acceptance and meaningful social relationships (Baumeister and Leary, 1995; Deci and Ryan, 2000); and fair distribution of costs/benefits of governance, including economic resources (Dawes et al., 2007; Fehr and Gächter, 2002; Ostrom, 1990). As described later, social relationships and governance systems are the primary sources for need satisfaction in society (Frey et al., 2004; Ryan and Deci, 2017b).

Rational choice theory traditionally acknowledges only three basic needs, arguing that narrow desire for individual self-determination (i.e., control), security, and economic welfare fundamentally drive self-interest (e.g., Hardin 1968; Hobbes, 1651/1947). These needs compel individuals to behave in their exclusive self-interest. In contrast, HRCT argues that individuals are *humanistically self-interested*. Individual pursuit of self-determination, security, and economic welfare is tempered by equally important (social) needs for procedural justice, belonging, and equity. In many situations, these needs balance and constrain self-interest, directing individual self-interest towards more altruistic, socially-accepted ends (cf. Ryan and Deci, 2017a). Humanistic self-interest, thus, resembles earlier concepts by Adam Smith (1759/2010; "moral sentiments"), Alexis de Tocqueville (1853/2003; "self-interest rightly understood"), and Elinor Ostrom (1998, 2010b; "other-regarding preferences"). These earlier authors recognized that societies function because individuals internalize social ethics (e.g., reciprocity, equity) and exhibit concern for others' welfare (Bowles, 2008; Miller, 1999). HRCT asserts that humanistic self-interest—grounded in fundamental needs—drives cooperative self-governance.

Prior research has examined each of these needs separately, demonstrating that their satisfaction promotes cooperation (e.g., Dawes et al., 2007; De Cremer and Tyler, 2005; Deci and Ryan, 2000; Tyler, 2006). According to HRCT, such need satisfaction promotes cooperation by triggering *internalization* and *acceptance*: individuals willfully incorpo-

[1] Though ubiquitous, fundamental needs are culturally subjective, taking different forms in different cultures (Rudy et al., 2007; Chen et al., 2015).

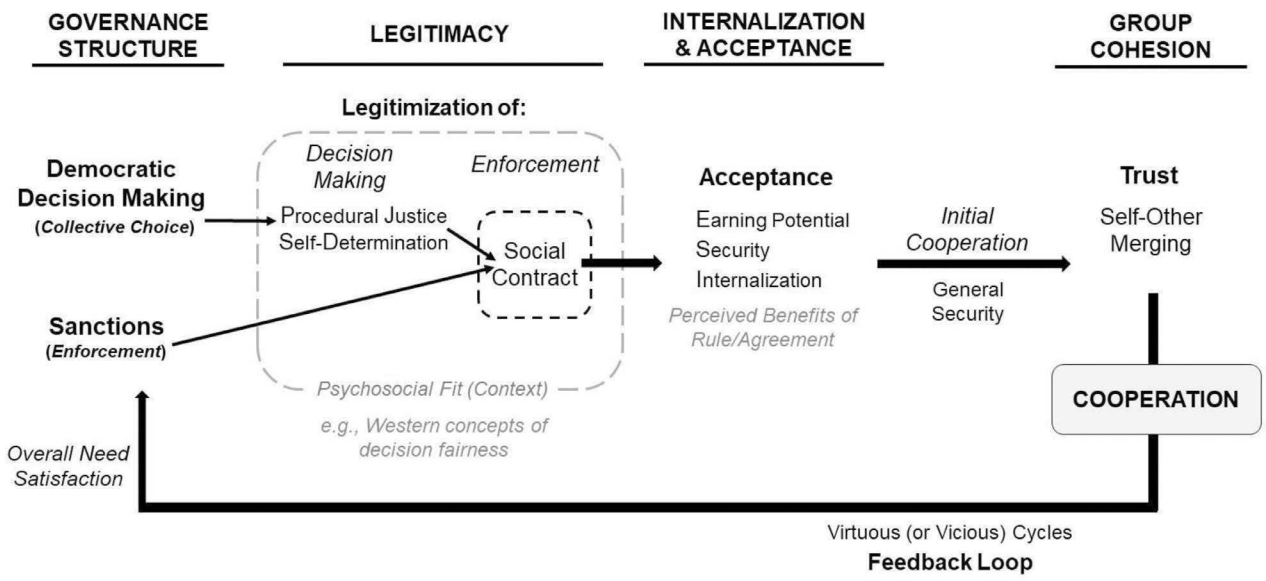

Fig. 2. Social Cognitive Process Linking Governance Structure to Cooperation.

rate the institutional arrangements (e.g., norms, agreements) into their self-identity and personal ethics (Deci and Ryan, 2000; Schafer, 1968). These individuals become intrinsically motivated, exhibiting robust voluntary cooperation. Individuals who do not internalize and accept social contracts typically exhibit poor voluntary cooperation; they are extrinsically motivated, requiring external motivators (punishment, external rewards) to cooperate (DeCaro et al., 2015; Sheldon and Elliot, 1998; Soenens et al., 2009).

3.2. Group cohesion: self-other merging and trust

Need satisfaction and institutional acceptance also improve cooperation by promoting group cohesion (DeCaro et al., 2015). *Self-other merging*, developing a positive, integrated group identity (i.e., transitioning from "I" to "We"), contributes to cooperation by increasing concern for others' welfare and aligning individual goals with group goals (De Cremer and Tyler, 2005; De Cremer and Van Vugt, 1999). Trust promotes cooperation because individuals are vulnerable in social dilemmas and must rely on others to behave altruistically (Ostrom, 2003). HRCT posits that group cohesion forms when initial acceptance of collective social contracts motivates individuals to initiate early (conditional) cooperation. This initial cooperation allows positive reputations to form (Abele and Stasser, 2008; DeCaro et al., 2015; Milinski et al., 2002; Rand et al., 2009): as individuals see others cooperating, they feel more secure and begin to merge with and trust those individuals (cf. Ostrom, 2003). This trust, reinforced by institutional acceptance, supports robust cycles of cooperation.

Unfortunately, it can be unclear which governance systems will adequately satisfy stakeholders' needs (Bowles, 2008; DeCaro and Stokes, 2013). HRCT addresses this issue by examining the fundamental needs and perceptions of legitimacy associated with the core elements of governance.

3.2. Legitimacy: collective choice and enforcement

Institutional legitimacy is strongly linked with cooperation (Tyler, 2006). Importantly, governance systems that satisfy needs for procedural justice and self-determination are often perceived as more legitimate. Such institutional legitimacy strongly contributes to formation of institutional acceptance and trust, thereby promoting voluntary cooperation (De Cremer and Tyler, 2005; Frey et al., 2004; Tyler, 2006).

Many factors may affect perceived legitimacy. However, prior research has demonstrated a strong relationship between institutional legitimacy and fair, autonomy-supportive decision-making procedures that provide individuals with culturally appropriate levels of voice and choice (e.g., democratic group decision-making processes in Western cultures; Colquitt, 2001; McComas et al., 2011; Tyler, 2006; Tyler et al., 1985; cf. DeCaro and Stokes, 2013). There are many ways collective choice can backfire (Cohen and Wiek, 2017; DeCaro et al., 2017a). Nevertheless, effective governance systems often use collective choice procedures to decide important decisions (Cox et al., 2010; Ostrom, 1990).

Effective governance systems also use enforcement (e.g., behavioral monitoring, economic penalties) to ensure compliance (Cox et al., 2010; Ostrom, 1990). Based on rational choice theory's assumption that individuals are selfish egoists, it has been argued that strict external enforcement is necessary, perhaps sufficient, to ensure robust cooperation in social-ecological dilemmas (Becker, 1974; Hobbes, 1651/1947; cf. Ostrom, 1980; Ostrom et al., 1992; Bowles, 2008). Well-designed enforcement systems improve cooperation by deterring potential defectors, creating security and protecting individuals who have accepted rules and agreements (e.g., Epstein, 2017; Fehr and Gächter, 2002; Rustagi et al., 2010). However, enforcement can also backfire, undermining institutional acceptance and trust—increasing rather than decreasing defection (e.g., Cardenas et al., 2000; Chen et al., 2015; Gneezy and Rustichini, 2000; Janssen et al., 2010; McCusker and Carnevale, 1995; Tenbrunsel and Messick, 1999; cf. Bowles, 2008; Ostrom, 2000).

Many mechanisms of counterproductive enforcement have been identified (Bowles, 2008; Ostrom, 2000; Ryan, 1982). HRCT (DeCaro, 2018, 2019) argues that enforcement is especially likely to backfire—crowding-out intrinsic motivation—when it has not been properly legitimized by fair decision processes (cf. Gibson, 1989; Tyler, 1990, 2006). When legitimized, enforcement does not simply deter potential defectors, it protects group agreements, empowering individual and group interests. Illegitimate enforcement oppresses individuals, inciting reactance and instilling extrinsic motivation (DeCaro et al., 2015). Thus, fair decision processes and enforcement are mutually reinforcing, balancing external regulation with self-regulation. Ostrom (1990, 2000) observed that enforcement within well-functioning self-governing systems is often created and decided by collective choice, not imposed unilaterally (cf. Cox et al., 2010). Several recent studies confirm this observation, noting that cooperation improved when economic sanctions were democratically chosen, or used

to enforce democratic decisions (DeCaro et al., 2015; Epstein, 2017; Grossman and Baldassarri, 2012; Hilbe et al., 2014; Markussen et al., 2014; Ostrom et al., 1992; Vollan, 2008; Vyrastekova and van Soest, 2003; Yamagishi, 1986).

HRCT proposes that such legitimization occurs because fair and autonomy-supportive decision procedures (e.g., democratic decision-making) satisfy fundamental needs for procedural justice and self-determination, thereby legitimizing the resulting social contract and its enforcement (Fig. 2: Legitimacy). Enforcement of the social contract then protects the agreement, satisfying the need for rule security and economic welfare (see Security, Earning Potential depicted under Acceptance in Fig. 2). This process then bolsters institutional acceptance and trust, as previously described. If the resulting institutional arrangements are effective, a virtuous cycle of cooperative self-governance emerges, helping to resolve the dilemma, thereby satisfying other needs (e.g., competence, equity).

This legitimization hypothesis has not been adequately tested in group communication experiments. Most studies of fair decision making in social dilemmas either study leadership and voting without communication (e.g., De Cremer and Van Vugt, 1999; Hilbe et al., 2014; Van Vugt et al., 2004; Vollan, 2008; Vyrastekova and van Soest, 2003) or do not comprehensively measure underlying motivations and perceptions (e.g., Janssen et al., 2010; Kerr and Kaufman-Gilliland, 1994; Orbell et al., 1988; Ostrom et al., 1992; Pavitt, 2011; Yu et al., 2016; cf. Anderies et al., 2011; DeCaro, 2019).

DeCaro et al. (2015) provided a partial test of this prediction in an experiment involving a majority vote mechanism (without communication). Participants in 40, four-person groups competed for valuable tokens in the previously-described foraging task (Fig. 1). During Phase 1, there were no resource management rules. At the beginning of Phase 2, some groups anonymously voted on a predetermined list of conservation rules (Voted Condition). Others could also enforce the rules with economic sanctions (Voted-Enforce Condition). Two additional groups lacked voting (Imposed Condition, Imposed-Enforce Condition). During Phase 3, enforcement was removed from the Voted-Enforce and Imposed-Enforce conditions to observe voluntary cooperation.

During Phase 1, every group rapidly destroyed the resource. However, during Phase 2, cooperation and resource sustainability improved substantially in the Voted-Enforce condition. This cooperation continued voluntarily during Phase 3 after enforcement ended. Cooperation improved moderately in the Voted Condition (which lacked enforcement) and Imposed Condition (which lacked democracy). However, there was no discernable improvement in the Imposed-Enforce Condition.

These voting and enforcement effects were mediated by corresponding effects in need satisfaction, acceptance, and group cohesion. Groups in the Voted-Enforce condition reported the highest levels of procedural justice and self-determination (from voting), intrinsically-motivated rule acceptance, security, and self-other merging. These factors were undermined in the Imposed-Enforce condition. Subsequent analyses, which tracked rule acceptance at the beginning and end of Phase 2, revealed that the Voted-Enforce Condition was the only condition in which initial levels of acceptance increased over time, indicating a virtuous cycle reinforced by both fair decision making and enforcement. Altogether, voting, enforcement, acceptance, and self-other merging (trust was not measured) accounted for 42% of the variance in Phase 3 voluntary cooperation. As explained next, we believe the same factors and processes are involved in communication effects, and emergence of self-governance.

4. Current study

HRCT (DeCaro, 2018, 2019) assumes that poorly managed resource dilemmas threaten fundamental needs. These need deficits motivate individuals to communicate and cooperatively self-govern to restore their interdependent needs (see generally, Chen et al., 2015; Vansteenkiste and Ryan, 2013; see also, Ryan and Deci, 2017a; Van Vugt, 2009). In a poorly-managed resource dilemma, the resource rapidly collapses. We believe this failure not only decreases everyone's economic welfare, but also undermines competency needs (cf. Bandura, 2010; Van Vugt, 2009) and increases animosity and distrust (Abele and Stasser, 2008), undermining belonging needs (De Cremer and Tyler, 2005). Poor collective decision making undermines procedural justice and self-determination (DeCaro et al., 2015). Finally, the lack of conservation agreements, and uncontrollable actions taken by others, undermine perceived security (Hardin, 1968; Hobbes, 1651/1947; Ostrom, 1990) and yield unequal resource shares (i.e., earnings), undermining equity (Dawes et al., 2007; Fehr and Gächter, 2002).

HRCT therefore predicts that, if dilemma stakeholders communicate, many individuals will be motivated to form social contracts and devise simple decision-making and enforcement systems to restore their fundamental needs. If the collective makes important decisions fairly, then their needs for procedural justice and self-determination will be satisfied, legitimizing subsequent decisions and their enforcement, promoting cooperation.

In the current study, we use the same basic experimental design as the DeCaro et al. (2015) voting experiment, but with unguided stakeholder communication. Groups completed the foraging task without communication (Phase 1), with communication (Phase 2), and then without communication (Phase 3). Rational choice theory claims that communication cannot improve cooperative governance of resources without direct intervention (i.e., rulemaking and enforcement) by an outside authority (Hardin, 1968; Hobbes, 1651/1947). Unaided communication is therefore the ideal way to examine individuals' natural potential for self-governance (Anderies et al., 2011; Ostrom, 2006; Ostrom et al., 1992).

4.1. Hypotheses

Our hypotheses followed the diagram of HRCT illustrated in Fig. 2. First, we predicted that during Phase 1 (no communication), groups would cooperate poorly, collapsing the resource and undermining their needs, self-other merging, and trust. Second, we expected the need deficits to motivate group members to use communication during Phase 2 as an opportunity to create conservation agreements and simple governance systems (i.e., self-govern). If so, then need deficits measured during Phase 1 should correlate with participants' self-reported goal to create conservation agreements during Phase 2. Additionally, if given the opportunity to report their conceptualization of the dilemma ("problem construal"; Weber et al., 2004), participants should (a) perceive the situation as a cooperative dilemma, rather than a purely competitive dilemma and (b) spontaneously espouse desires to cooperate, specifically to improve everyone's welfare, not just their own. In addition, (c) overall need satisfaction during Phase 2 should mediate the relationships between their group decision-making processes, enforcement, and voluntary cooperation during Phase 3.

Specifically, groups that make decisions democratically during Phase 2 should report greater procedural justice and self-determination. These perceptions should legitimize the use of enforcement (social sanctions) by the group (Legitimacy: Fig. 2). Legitimization should increase institutional acceptance (Internalization, Acceptance: Fig. 2), because the agreement(s) chosen will be perceived as increasing individuals' earning potential (economic welfare), rule security, and rule internalization (i.e., match to individuals' core desires/values). Acceptance (and initial cooperation) should be associated with an increase in general security (i.e., predictability and safety from uncertainty in the overall dilemma), and formation of group cohesion (i.e., self-other merging and trust). These factors—acceptance and trust—should be highly predictive of voluntary cooperation during Phase 3, when communication and social sanctioning are no longer possible. In contrast, groups with poorer democratic decision making should be less able to promote internalization and acceptance of their social contracts, or legitimize their use of social sanctions. Therefore, negative social sanctions (e.g., shaming, threats)

should backfire in these groups, undermining voluntary cooperation in Phase 3.

5. Methods and materials

5.1. Participants

We conducted this experiment in a large Midwestern public U.S. university. Participants were undergraduates (N = 164) recruited for an "economic decision-making experiment" from a wide range of introductory general education courses (57% female, age M = 19.56, SD=3.60). Participants received $3 for participation and could earn up to $30, depending on individual and group decisions in the dilemma. Half the participants (54%) were psychology students, who also received 0.5 research credits for participation. There were no significant differences in results between psychology students and other participants.

5.2. Experimental design and procedure

Participants were run in sessions of 8 to 12 individuals at a time. After administering informed consent, we escorted participants to private cubicles, where they read introductory instructions explaining payment, the decision task, and resource system on the computer. Participants completed a quiz to ensure they understood the instructions, earning $0.10 for each correct answer ($0.50 maximum). The computer automatically provided feedback, explaining the correct answers. The experimenter also read key information from the instructions aloud and answered any questions before continuing to a four-minute practice period, in which participants could practice collecting resources in a private resource pool.

After practice, the computer randomly assigned participants to an anonymous, four-person group (N = 41 groups) and began Phase 1. The resource system (foraging task) was identical to that of DeCaro et al. (2015). During each round of the foraging task, group members accessed a shared resource pool in a field consisting of a 26 × 26 grid, for four minutes. At the beginning of each round, 25% of the field was randomly populated with tokens (N = 169) worth $0.02 each. The tokens proliferate based on density (faster generation within denser clusters) and stop reproducing when all the tokens are collected. Many conservation strategies improve resource sustainability. However, the optimal strategy is to delay harvests for two minutes, and then slowly harvest tokens in a checkerboard pattern (thinning clusters) until the last 30 s of the round. The resource pool will grow to 548 tokens, allowing each person to collect approximately 137 tokens ($2.47 per round), for a total of $24.66 (1233 tokens) across all nine rounds of the experiment. If groups do not conserve the resource—rapidly harvesting every token—then only 232 tokens will emerge, and individuals will collect only 58 tokens ($1.16) per round, or $10.44 total (see Appendix for additional details).

There were three phases of the experiment. Each phase entailed three foraging rounds (9 total). During Phase 1 (Baseline: Rounds 1–3), group members could not communicate. During Phase 2 (Communication: Rounds 4–6), group members could communicate for five minutes before each round, using group text messages (identified only by their Player number 1–4). Participants could also communicate via text during each round. Participants were not required or instructed to communicate, and were not given guidance, except that physical threats and outside deals were forbidden. Communication was disabled during Phase 3 (No Communication: Rounds 7–9). This design allowed us to examine cooperation before, during, and after communication.

We administered three surveys on the computer, immediately after each phase, before instructions for the next phase were presented. Surveys 1 and 2 assessed participants' motivations and perceptions after Phases 1 and 2. Survey 3 measured basic demographic information. After Survey 3, we thanked, debriefed, and privately paid each participant. Our experimental materials, psychological surveys, software, and protocol are described in the Appendix (and publicly archived at Zenodo). Our raw and analyzed data are publicly archived online at OSF.

5.3. Communication coding

We coded both the topical content and function (e.g., collective choice, enforcement) of the group communication to better understand the potential relationship to self-governance.

Communication Content. To code the topical content of group communication, we developed a line-by-line coding system with 28 categories (plus eight sanctions). We started with a-priori categories based on theory (DeCaro, 2019; Gardner et al., 1990) and prior research (e.g., Janssen, 2010; Pavitt, 2011). We expanded and refined these categories iteratively (for guidelines followed, see: Brauner, 2018; Ratajczyk et al., 2016; Reed et al., 2018).

Coding group communication requires considerable domain knowledge because communication is contextual. Communication is specific to the social-ecological dilemma, group culture, and history (e.g., prior and recent events within the group). Our system involves 36 coding categories. For such intensive coding tasks it is recommended that a reliability coder code 15–20% of the observations (Seelandt, 2018). Therefore, a highly experienced primary coder coded all 41 groups, and a trained undergraduate research assistant coded eight randomly-selected groups (i.e., 20%). Percentage agreement among coders was 73%. *Cohen's Kappa* for assessing inter-rater reliability was 0.71, indicating "substantial" reliability (Seelandt, 2018), especially considering the complexity of the coding task and difference in expertise among coders.[2]

The primary topical categories pertained to information exchange (e.g., ecological, social, behavior, institutional), group decision-making (e.g., proposals, choosing), conservation agreements, social sanctions (e.g., praise, shaming), and off-topic discussion (e.g., humor; see Appendix). Groups communicated an average of 98.41 thought units (SD=38.93, *range*:40,193). However, we do not describe these categories in detail here (see Appendix; Table A.2). Like other experiments (e.g., Janssen, 2010; Janssen et al., 2010; Pavitt, 2011), the frequency that individuals discussed particular topics in line-by-line coding had little association with observed outcomes (cf. Anderies et al., 2011). This finding is likely due to a ceiling effect: most groups discussed important information and developed similar conservation strategies, as described later. Additionally, line-by-line frequency coding ignores important aspects of context and function (Brauner, 2018; Reed et al., 2018). Functional coding was more explanatory. For example, although an average of 24% of all group communication pertained to collective choice (e.g., proposals, choosing), the factor that best predicted Phase 3 cooperation was a functional index, measuring degree of democratic decision making.

Democratic Decision-Making. To examine democratic decision making, we created a *democratic decision-making index* (*DDM*) based on similar indices in prior experiments (Vyrastekova and van Soest, 2003; Yu et al., 2016). We identified each major decision event, beginning with a proposal (typically a proposed conservation strategy) and ending with a clear choice among options, no choice, or end of communication time. For each event, we counted how many group members explicitly chose a particular proposal (e.g., conservation strategy; see Codebook and Appendix). With 4 group members, this score could range from 0 (*no decision/unresolved/contested*) to 4 (*4-person majority*). We averaged these scores across the group's total number of decision events, creating an overall indicator, which represents the extent to which group decisions were decided by all four group members. We also computed a *Gini-coefficient of deliberation* (cf. Janssen, 2010), which determines whether group members contributed equally to discussion during each

[2] The Codebook (DeCaro, 2021) is publicly archived at SocArXiv.

decision event. However, this indicator had no discernable relationship with cooperation (see Appendix).

Social Sanctions. We coded eight sanctions: acknowledgement, praise, request, tell, shame, warn, threaten, and punish (see Codebook and Appendix). These sanctions fall within two general categories, positive sanctions (e.g., praise) and negative (e.g., warnings). For example, *praise* refers to praise, celebration, or encouragement of cooperation. *Warnings* refers to warning ("informing") individuals of retaliatory consequences for defection.

In contrast to the line-by-line content coding, which examines the absolute frequency that particular sanctions were used, we created a functional coding index, which was the proportion of particular sanctions used by each group, out of the total number of sanctions used by that group. For example, if a group used 10 sanctions, and 7 were praise, then the praise functional score would be 0.70. As described later, we used these scores to create an overall index, representing the relative reliance on positive versus negative sanctions.

Conservation Agreements. We coded groups' conservation agreements, using both their self-reported descriptions (Survey 2) and communication. We recorded any strategies mentioned by at least two group members (cf. Yu et al., 2016) and compared across self-report and in-game communication, for consistency. The most common strategies were *private property* (dividing the resource field into four plots for individual use; 32 groups, 78%), *delayed harvest* (waiting to harvest; 10 groups, 24%), and *checkerboard harvest* (harvesting in a "checkerboard" pattern to optimize regrowth; 8 groups, 20%). Most groups used a combination of strategies (e.g. private property plus delayed harvest; Appendix: Table A1). The coded survey and in-game strategies were closely matched (86% if considering all components; 100% if considering only the primary, i.e., first two components; see Agreement Codes in Dataset 2). We therefore used the coded survey strategies for our analyses. The survey responses provided more direct confirmation of groups' strategies, having come from participants' own explanations.

5.4. Psychological measures

The psychological survey measures were based on conventional measures (e.g., Colquitt, 2001; Sheldon and Elliot, 1998; Sheldon et al., 2001) previously adapted for use in social dilemmas (see, DeCaro et al., 2015). Participants responded on 7-point scales, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

5.4.1. Survey 1

Survey 1 was administered immediately after Phase 1 and measured current thoughts and perceptions about the dilemma, need satisfaction, and group cognitions.

Current Thoughts. We included two short essay questions asking participants' current thoughts about the dilemma, to understand how they construe the situation (*Problem Construal*): "What things do you feel are going WELL (POORLY) in the token task situation right now?" If most individuals are narrowly self-interested, then they should view the situation as a competition and celebrate earning more for themselves, at others' expense (cf. Weber et al., 2004). However, if most individuals are humanistically self-interested, then participants should lament the situation as a failed cooperative endeavor and wish to cooperate specifically to improve everyone's earnings, not just their own (cf. Dawes et al., 2007).

Perceptions of the Dilemma. Two items each assessed perceived *chaos* (e.g., whether the dilemma felt "disorganized and chaotic"; *Cronbach's* α=0.84), *resource management* (e.g., whether the group was, "doing a good job of managing the tokens"; α=0.91), *cooperativeness* (e.g., whether the group was, "being cooperative and helpful;" (Tenbrunsel and Messick, 1999); and *overall perceptions* (e.g., whether participants felt it was "going well in the token task"; α=0.94).

Need Satisfaction. We assessed four needs associated with the dilemma. Three items each assessed perceived *security* (e.g., "The token task, and the way my group is behaving, feels well-structured and predictable;" α=0.83; cf. Sheldon et al., 2001), *equity* (e.g., "Everyone is getting a fair share of the tokens;" α =0.87; cf. Tyler et al., 1985), and *belonging* (e.g., "My group makes me feel like I belong;" α=0.91; cf. Cameron, 2004). Six items assessed *perceived behavioral control* (α=0.90), consisting of two subscales: *competence* (e.g., "The way the token task is going right now makes me feel competent"; cf. Ryan, 1982), *controllability* (e.g., "I am satisfied with how much control I have over the token task, and my group, right now"; cf. Fishbein and Azjen, 2010).

Group Social Cognitions. Seven items assessed *self-other merging* (α=0.94). One item used Venn diagrams (overlapping circles) to assess felt closeness to one's group (De Cremer and Tyler, 2005). Six additional items assessed *emotionality* (e.g., "I feel positively towards the other people in my group") and *connectedness* (e.g., "I feel like I really 'fit in' with the other people in my group"; cf. Cameron, 2004). Four items (α=0.94) assessed *trust* (e.g., "I feel like I can trust the other people in my group"; e.g., Chen et al., 2009).

5.4.2. Survey 2

We administered Survey 2 after Phase 2. Participants first described their group's conservation strategies and indicated their acceptance and compliance motivations. Next, participants indicated the procedural justice and self-determination derived from group communication and decision-making processes. Participants then indicated their goals for communication. Finally, participants again reported their current perceptions of the dilemma (e.g., basic need satisfaction), using the same items as Survey 1.

Conservation Strategies. One short essay question asked participants to "describe and explain any rules and agreements" their group made to manage the tokens.

Institutional Acceptance. Three items assessed participants' acceptance of their group's conservation strategies (e.g., "I approve of the rules/agreements my group made to manage the tokens"; Allen and Meyer, 1990; cf. Colquitt, 2001).

Compliance Motivations. We assessed several intrinsic and extrinsic compliance motivations to determine the extent to which participants' rule acceptance was internalized and intrinsically motivated (Sheldon and Elliot, 1998; Soenens et al., 2009). Participants were asked why they obeyed their group's conservation strategies (cf. DeCaro et al., 2015). Three items each assessed *social pressure* (*R.PRESS:* e.g., "I thought my group members would disapprove of my behavior, if I did not obey the rules/agreements;" α=0.76), *punishment* (*R.PUNISH*: e.g., "I thought I would be punished if I did not follow the rules/agreements;" α=0.77), *anticipated earnings* (*R.EARN:* e.g., "I thought that the rules/agreements would help me get more tokens (money);" α=0.93), *guilt* (*R.GUILT: e.*g., "I did not want to feel guilty for disobeying the rules/agreements;" α=0.89), *security* (*R.SECURITY*: e.g., "I felt that the rules/agreements would keep me safer from uncertainties;" α=0.77), and *internalization* (*R.INTERN*: e.g., "I felt that they matched with my personal values and desires;" α=0.71).

Communication Goals. We assessed 17 potential goals for communication (e.g., cooperation, sustain resource, deceive others; see Appendix 4.2).

Procedural Justice and Self-Determination (PJSD). We assessed two aspects of fairness in group communication. Three items each assessed perceived *procedural justice* (e.g., "I felt like the people in my group encouraged open communication and welcomed my input;" α=0.90), and *interpersonal justice* (e.g., "I feel like the people in my group communicated in a courteous way;" α=0.90; cf. Ku et al., 2013). Two additional items assessed *overall fairness* (e.g., I feel like my group's communication process was fair;" α=0.87; van Prooijen, 2009).

We also assessed the perceived fairness and self-determination of each group's collective decision-making process. Participants responded to this prompt: "The way my group made decisions about what to do in the token task…" Two items assessed *procedural justice* (e.g., "was free of bias and consistent with my ethical and moral standards;" α=0.87; cf.

Colquitt, 2001). We assessed three aspects of self-determination: *internal perceived locus of control* (3 items; e.g., "…made me feel as if I had some control over how the situation went;" α=0.86; cf. Levenson, 1980), *choice* (3 items; e.g., "…made me feel as if I had some choice about what to do;" α=0.89; cf. Ryan, 1982), and *self-concordance* (4 items; e.g., "free to do things that agree with my true interests and values;" α=0.77; cf. Sheldon et al., 2001). Perceptions of communication and group decision making were correlated, $rs(39)\geq 0.86$, $p<.001$; Appendix: Table A5). Therefore, we combined the component measures into a single factor (*PJSD),* representing the procedural justice and self-determination individuals felt from their group's communication and decision-making processes.

6. Results

HRCT (Fig. 2) predicts that communication improves cooperation and resource sustainability when groups use fair, autonomy-supportive decision procedures (e.g., democratic decision making: DDM) to make group decisions and form conservation agreements (social contracts). Such decision procedures satisfy fundamental needs for procedural justice/self-determination (PJSD). This process legitimizes enforcement (e.g., social sanctions) and increases rule internalization and acceptance, enhancing general security, group cohesion (self-other merging), and trust via initial cooperation levels. These psychosocial processes drive a virtuous cycle of conditional cooperation, strengthening the group social contract, rule acceptance and trust, and resource sustainability.

To evaluate these predictions, we first examined the overall effect of communication on group cooperation, in terms of resource sustainability. Afterward, we examined the psychosocial processes associated with cooperation. We first tested the legitimization hypothesis. We examined whether democratic decision making and enforcement (social sanctions) interact, moderating rule acceptance levels, and whether this relationship was mediated by procedural justice/self-determination (*PJSD*). Second, we examined the hypothesized psychosocial determinants (correlates) of rule acceptance. Based on the DeCaro et al. (2015) voting and enforcement experiment, we predicted that democratic group decision making (*DDM*) and social sanctions jointly increase rule acceptance by increasing participants' expected earnings from the rule (*R.EARN*), rule security (*R.SECURITY*), and rule internalization (*R.INTERN*). Third, we examined trust. Because rule acceptance is hypothesized to be a precondition for initial cooperation, security, and self-other merging, we expected trust levels to be associated with rule acceptance (*ACCEPT*), general security (*G.SECURITY*), and merging (*S.MERGE*). These analyses clarify the psychosocial processes associated with institutional acceptance and trust. Finally, we used these factors (DDM, enforcement, acceptance, and trust) to account for voluntary cooperation during Phase 3.

To conduct these analyses, we used Hayes' (2018) method and statistical macro (*Process 3.5.3*) for analyzing moderation and mediation effects. *Process* quantified all direct effects using OLS. Indirect effects (i.e., mediation effects) were further tested using Hayes' index of moderated mediation, using 10,000 bootstrapped samples to provide stable estimates for significance tests. Our predictions centered on group-level processes, rather than individuals. Conventions for analyzing individual/group-level observations in cooperative experiments differ by discipline. The research that most directly informed the current experiment aggregated observations at the group level, using group means to examine group processes and outcomes (e.g., DeCaro et al., 2015; Janssen, 2010; Janssen et al., 2010; Ostrom et al., 1992). Therefore, we used group data for each of these analyses.

Many factors affect sample size considerations and statistical power, including effect size, number of predictors in the model, and measurement precision (e.g., survey reliability; Fritz and MacKinnon, 2007; Fritz et al., 2015). Generally, researchers recommend at least 5–10 observations for each predictor in a regression model, assuming moderate precision and effect sizes. Fritz and MacKinnon (2007) further recommend a total sample of 34–55 observations for large/moderate effects (see also, Hayes, 2018). TheDeCaro et al. (2015) voting/enforcement experiment observed moderate to large effect sizes with 40 groups and highly reliable measures (*Cronbach alphas* typically greater than 0.85). We adapted the same methods for the current study. We anticipated (and found) moderate to large effects, and our most complex models contain five predictors. Thus, the current experiment's sample size ($N = 41$) falls within recommended ranges.

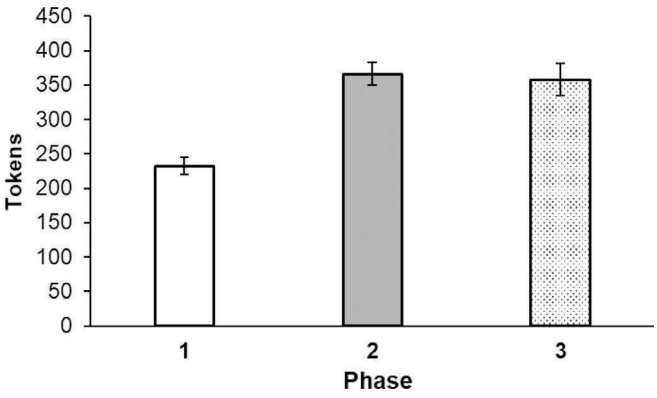

Fig. 3. Cooperation (Mean Group Harvests). Phase 1 (no-communication baseline). Phase 2 (communication). Phase 3 (communication removed). Error bars=95%CIs. $N = 41$.

6.1. Cooperation

In the foraging task, groups that cooperate better sustain the resource longer, thereby collecting more tokens (see Appendix 1.3). As expected, cooperation was poor during Phase 1. The resource collapsed, yielding low overall harvests (Fig. 3). Cooperation improved with communication (Phase 2), $F(1,40)=285.23$, $p<.001$, $\eta^2=0.87$, and remained high (i.e., no decline) even after communication ended (Phase 3), $F(1,40)=1.88$, $p=.178$, $\eta^2=0.05$.

6.2. Psychosocial processes

All cooperation in this experiment is voluntary, because participants cannot use tangible economic sanctions (i.e., fines) to formally punish rule defectors. However, to provide the strongest test of the factors associated with voluntary cooperation, we examined Phase 3 cooperation—when groups could no longer communicate or use social sanctions (e.g., praise, threats) to informally enforce their agreements. Additionally, we used factors measured during Phase 2 (e.g., coded decision-making processes, perceived PJSD) to predict Phase 3 cooperation.

In the prior study conducted by DeCaro et al. (2015) prior study, fair decision processes (voting) and enforcement (sanctions) were experimentally controlled. We lacked control of these naturally occurring processes in the current study. This design feature was intentional. An unmanipulated collective choice situation provides the strongest test of the assumption that individuals are too narrowly self-interested to self-govern. Nevertheless, we treat democratic decision making (*DDM*) as potentially causal, because logically and empirically speaking (see Codebook), group decisions (decision events) occur before rules and agreements, because group decisions create agreements. The psychosocial processes associated with these decisions, therefore, logically emerge from those prior decision events and procedures. Similarly, enforcement of a rule/agreement must come after creation of the rule/agreement. Thus, we based each model on HRCT (DeCaro, 2018, 2019) and our a-priori prediction (DeCaro et al., 2015) that DDM and enforcement influence cooperation by affecting perceptions of PJSD, followed by rule acceptance, and group social cognitions, such as self-other merging and trust. Our models are also consistent with prior experimental studies,

collectively confirming this causal order (e.g., Bendtsen et al., 2016; De Cremer and Tyler, 2005; Galbiati et al., 2018; Kerr and Kaufman-Gilliland, 1994; Kerr et al., 1997; Orbell et al., 1988; Rand et al., 2009, 2014; cf. DeCaro et al., 2020; Deci and Ryan, 2000; Tyler, 2006).

However, psychosocial processes such as acceptance and trust likely emerge and develop across the three rounds of communication (Phase 2) used in this experiment. Thus, we cannot entirely rule out reciprocal relationships among these psychosocial processes. We discuss potential alternative interpretations for future research to disentangle, in the Discussion.

6.2.1. Preparatory analyses

We first discuss preparatory analyses—examining overall levels of democratic decision making, social sanctions, and their interrelationships—for use as key predictors in our models of group rule acceptance, trust, and Phase 3 voluntary cooperation.

Democratic Decision Making. Most groups made decisions democratically (DDMI: M = 3.56, SD=0.53). They also felt that their communication and decision-making processes were fair and autonomy-supportive (*PJSD:* M = 6.03, SD=0.74). Greater democratic decision-making (DDM) was associated with higher perceived procedural justice and self-determination (PJSD), $r(39)=0.60$, $p<.001$.

Social Sanctions. On average, groups used 15 social sanctions (M = 14.95, SD=8.35). Most were positive (praise 55.52%).[3] Groups used negative sanctions less frequently (telling 18.23%, shaming 9.58%, warning 5.41%, threatening 1.82%, punishing 0.18%). To capture each groups' relative use of each sanction, we computed their percentage usage: for example, Group 2 sanctioned 5 times (40% acknowledge, 40% praise, 20% threaten).

As expected, negative sanctions were positively correlated with each other, $rs(39)\geq.34$, $ps\leq.029$, and negatively correlated with praise, $rs(39)\leq-0.31$, $ps\leq.047$ (Appendix Table A.4). Preliminary analyses indicated that praise was positively correlated with Phase 3 cooperation, $r(39)=0.44$, $p=.004$. Shaming, warning, threatening, and punishing were generally negatively correlated with Phase 3 cooperation, $rs(39)=-0.25$ to -0.49, $ps=0.118$ to 0.001. We therefore created a single factor, *sanctions* (*SANCT*), representing the difference between a group's percent usage of praise versus all negative sanctions combined (i.e., percentage praise minus percentage negative sanctions). Hence more positive SANCT values indicate greater relative use of positive social sanctions. We created a *DDM* × *SANCT* interaction term to test the prediction that democratic decision making and sanctions reinforce one another (cf. DeCaro et al., 2015).

Model Predictors. The correlation among each predictor is shown in Table 1. We mean-centered each continuous predictor except SANCT, to improve interpretability of each effect in the model (Cohen et al., 2003; Hayes, 2018). Zero on each predictor represents the predictor's mean; zero on SANCT represents balance among positive and negative social sanctions.

6.3. Legitimization of enforcement

As shown in Table 1, DDM (democratic decision making) and (positive) social sanctions (SANCT) correlate positively with rule acceptance ($rs=0.60$), as anticipated. Furthermore, PJSD correlates strongly with acceptance (r = 0.81). To test the prediction that DDM legitimizes enforcement, we first examined the joint effect of DDM and SANCT on rule acceptance. Afterward, we mediated this relationship with PJSD.

There was a significant effect of DDM on acceptance (B = 0.66, $p<.001$; *95%CI*[0.44,0.89]) and a significant DDM × SANCT interaction ($B=-1.16$, $p=.001$; *95%CI*[−1.83,–0.49]). As illustrated in Fig. 4, when groups made decisions more democratically (higher DDM), negative and positive social sanctions were both associated with higher acceptance. However, when groups made decisions less democratically (lower DDM), negative social sanctions were associated with lower acceptance, and positive sanctions were associated with higher acceptance. Hence, positive sanctions (Phase 2) were associated with higher acceptance regardless of group decision process, but negative sanctions were associated with lower acceptance unless legitimized by democratic decision making. These results suggest that communication that included democratic decision making may have legitimized the use of sanctions, without undermining rule acceptance (cf. DeCaro et al., 2015).

This interpretation is consistent with another set of observations. Groups that used more sanctions typically used a higher percentage of negative sanctions, $r(38)=0.41$, $p=.007$ (vs. percentage praise: $r(38)=-0.39$, $p=.012$). Using more sanctions during Phase 2 was associated with lower Phase 3 cooperation, $r(39)=-0.33$, $p=.038$. In addition, groups with higher DDM used negative sanctions less frequently, $r(39)=-0.57$, $p<.001$.

Hence, negative social sanctions escalated in less democratic groups, without reducing defection. For example, Group 41 (*DDM*=2.00) tentatively agreed to use a private property strategy, but Player 1 immediately defected. Player 1 was immediately shamed and warned but continued to defect. Player 3 tried to renew the agreement, but the decision was contested. Player 1 continued to defect, triggering more sanctions. Player 2 and 4 eventually banded against Player 1, taking Player 1's tokens as punishment, and everyone defected. Group 41's percent usage of negative sanctions was approximately 10 times that of all other groups (i.e., 24%, compared to just 2.68% *median*).

To further confirm the assumption that fair/autonomy-supportive decision processes legitimize enforcement, specifically by affecting perceptions of PJSD, we next conducted a mediation analysis in which perceived PJSD was used as a potential mediator of the relationship between the DDMI × SANCT interaction term and rule acceptance. If PJSD mediates this relationship (i.e., mediated moderation; Hayes, 2018), then the formerly significant DDMI × SANCT interaction term should drop to non-significance, and a PJSD × SANCT term should take its place, emerging as the significant predictor of acceptance. The results were consistent with this assumption. DDM remained significant (B = 0.44, $p=.019$; *95%CI*[0.08,0.81]), but the DDMI × SANCT interaction dropped to non-significance ($B=-0.59$, $p=.121$; *95%CI*[−1.33,0.16]), and the PJSD × SANCT interaction term emerged as marginally significant (B = 0.44, $p=.055$; *95%CI*[−0.01, 0.88]). Thus, the legitimizing effect of democratic decision making on enforcement was likely due to satisfaction of PJSD.

6.4. Rule acceptance

HRCT predicts that DDM and enforcement (*SANCT*) jointly improve rule acceptance because these factors provide an opportunity for group members to create and choose a conservation agreement that they (a) expect to earn more money from, due to better resource management (*R.EARN*), (b) feel more secure about (*R.SECURITY*), and (c) feel better matches their values/desires (*R.INTERN*). As in the DeCaro et al. (2015) experiment, these factors were positively correlate with rule acceptance (Table 1).

Overall, this model accounts for 73.61% of the variance in acceptance (Table 2, Fig. 5). As anticipated, *DDM* (B = 0.63, $p=.002$; 95%*CI*[0.24,1.03]) and the *DDM* × *SANCT* interaction ($B=-1.18$, $p=.032$; *95%CI*[−2.26,−0.11]) were significant predictors of the agreement's perceived earning potential (*R.EARN*). DDM with sanctions was associated with enhanced economic benefits of the group agreement. R.EARN was directly associated with rule security (B = 0.39, $p=.010$; *95%CI*[0.10,0.68]): participants felt more secure with agreements that had greater earning potential. Finally, *DDMI* × *SANCT* ($B=-0.83$, $p=.018$; *95%CI*[−1.51,−0.15]) and rule se-

[3] Preliminary analyses revealed two positive sanctions (acknowledge, request), did not correlate with any key factors, so they were dropped from analyses (Appendix: Table A.4). Thus, praise is the only remaining positive social sanction examined.

Table 1
Correlation among model predictors and outcomes.

		Mean (SD)	1	2	3	4	5	6	7	8	9	10	11
1	DDM	3.56(0.53)	–	.42**	.60**	.44**	.43**	.40**	.27	.60***	.40**	.43**	.36*
2	SANCT	0.51(0.31)		–	.47**	.51***	.22	.34*	.18	.52***	.33*	.42**	.49***
3	PJSD	6.03(0.74)			–	.85***	.49***	.51***	.62***	.81***	.82***	.81***	.55***
4	G.SECURITY (P2)	5.84(0.79)				–	.56***	.58***	.65***	.77***	.85***	.92***	.64***
5	R.EARN	6.24(0.64)					–	.54***	.49***	.58***	.45**	.49***	.32*
6	R.SECURITY	5.94(0.58)						–	.68***	.62***	.50***	.48***	.39*
7	R.INTERN	5.86(0.47)							–	.67***	.63***	.60***	.33*
8	ACCEPT	6.41(0.52)								–	.68***	.71***	.47**
9	SELFMERGE (P2)	5.44(0.75)									–	.87***	.42**
10	TRUST (P2)	5.43(0.92)										–	.63***
11	PHASE 3 TOKENS	357.63(74.99)											–

Note: DDM=democratic decision-making index. SANCT=social sanctions (positive minus negative). PJSD=procedural justice/self-determination of communication and group decision-making. G.SECURITY (P2) =general security (i.e., felt security, Phase 2). R.EARN=compliance motivation due to perceived earnings of the rule. R.SECURITY=compliance motivation due to perceived security created specifically by the rule. R.INTERN=rule internalization. ACCEPT=rule acceptance. SELFMERGE (P2)=self-other merging, Phase 2. TRUST (P2)=trust, Phase 2. PHASE 3 TOKENS=tokens collected, Phase 3 (measure of voluntary cooperation). $N = 41$. $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$.

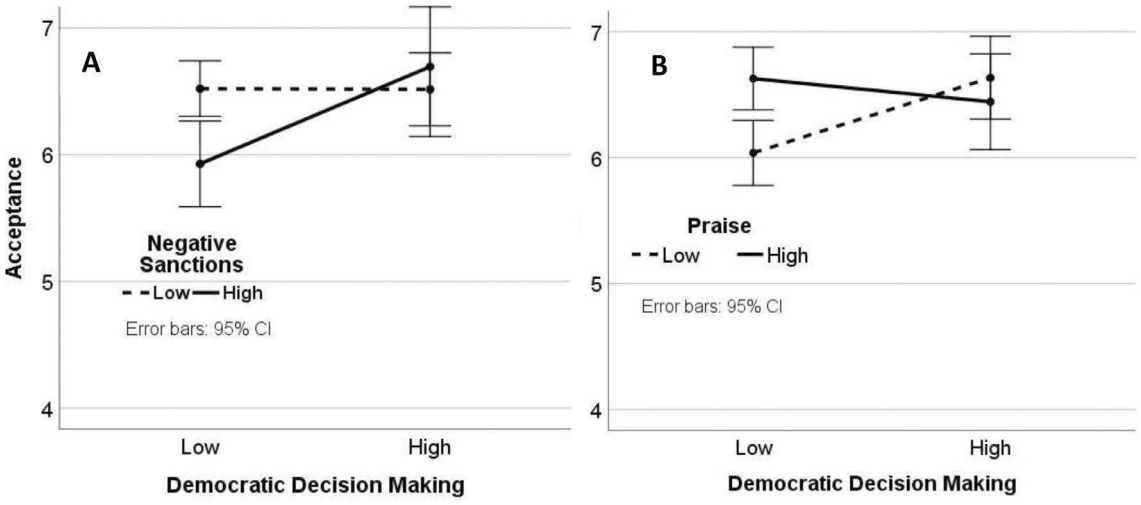

Fig. 4. Group Rule Acceptance as a Function of Democratic Decision Making (DDM) and (A) Negative Social Sanctions versus (B) Praise. Low/High=median split. Median DDMI=3.67. Median Praise=0.53. Median Negative Sanctions=0.03. Error bars=95%CIs. $N = 41$.

curity (*R.SECURITY*) ($B = 0.49$, $p<.001$; *95%CI*[0.26,0.72]) were directly associated with internalization, and internalization was directly associated with acceptance ($B = 0.42$, $p=.006$; *95%CI*[0.13,0.72]). Positive sanctions also had an overall positive association with acceptance ($B = 0.40$, $p=.031$; *95%CI*[0.04,0.76]).

Analysis of the indirect effects identified two potential pathways linking these factors with acceptance (Fig. 5). First, democratic decision making and social sanctions may improve acceptance by increasing internalization via two marginally-significant pathways (95%*CIs* slightly contain zero; Hayes, 2018): *DDM × SANCT → R.INTERN → ACCEPT* (*Index*=−0.35; *95%CI*[−0.74,0.02]). Second, *DDM × SANCT* may also exert its effects via the larger path: *DDM × SANCT → R.EARN → R.SECURITY → R.INTERN → ACCEPT* (*Index*=−0.10; *95%CI*:[−0.30,0.07]).

6.5. Trust

HRCT assumes trust develops when fair/autonomy-supportive decision making combined with enforcement (a) enhances rule acceptance (Fig. 4), generating initial (conditional) cooperation, which (b) builds general sense of security, triggering (c) formation of group cohesion (self-other merging) and trust.

To test this prediction, we conducted a second process analysis. For this analysis, security refers to general security (*G.SECURITY*), the overall security individuals felt by the end of Phase 2 (Table 3, Fig. 6). Overall, the model accounted for 87.97% of the variance in group trust. The significant *DDMI × SANCT* interaction on acceptance was mediated by G.SECURITY, with ACCEPT emerging as a significant predictor of G.SECURITY ($B = 0.99$, $p<.001$; *95%CI*[0.51,1.47]). G.SECURITY was also a predictor of self-other merging (S.MERGE; $B = 0.78$, $p<.001$; *95CI*: 0.51,1.05). Finally, G.SECURITY ($B = 0.80$, $p<.001$; *95%CI*[0.48,1.12]) and S.MERGE ($B = 0.38$, $p=.011$; *95%CI*[0.09,0.67]) were both associated with TRUST.

Two pathways emerged as significant. *DDMI × SANCT* may exert its effect via a security-enhancing pathway: *DDMI × SANCT → ACCEPT → G.SECURITY → TRUST* (*Index*=−0.79; *95%CI*[−1.75,−0.04]). *DDMI × SANCT* may also exert its effect via a larger group-cohesion pathway, involving self-other merging: *DDMI × SANCT → ACCEPT → G.SECURITY → S.MERGE → TRUST* (*Index*=−0.30; *95%CI*[−0.93,−0.02]).

6.6. Phase 3 voluntary cooperation and resource sustainability

Having demonstrated how rule acceptance and trust may have emerged, we next examined Phase 3 voluntary cooperation/resource sustainability (i.e., average group harvests during Phase 3). Preliminary analyses (Table 1) revealed that voluntary cooperation was positively correlated with democratic decision making (*DDM:* $r = 0.36$), relative

Table 2
Model coefficients: phase 2 rule acceptance.

	M_1:R.EARN			M_2:R.SECURITY			M_3:R.INTERN			Y:ACCEPT		
	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*
Constant	.14(0.20)	.501	[−0.27,.55]	−0.17(0.18)	.353	[−0.53,.19]	.17(0.12)	.186	[−0.08,.42]	6.24(0.11)	<0.001	[6.01,6.46]
X (DDM)	.63(0.19)	.002	[.24,1.03]	.15(0.19)	.438	[−0.24,.54]	.11(0.13)	.391	[−0.15,.38]	.33(0.11)	.007	[.10,.56]
W (SANCT)	−0.11(0.33)	.730	[−0.79,.56]	.34(0.29)	.252	[−0.25,.93]	−0.22(0.20)	.291	[−0.63,.19]	.40(0.18)	.031	[.04,.76]
XW	−1.18(0.53)	.032	[−2.26,−0.11]	−0.08(0.49)	.874	[−1.08,.92]	−0.83(0.34)	.018	[−1.51,−0.15]	−0.35(0.31)	.270	[−0.98,.28]
M_1(R.EARN)	—	—	—	.39(0.14)	.010	[.10,.68]	.05(0.11)	.613	[−0.16,.27]	.11(0.09)	.240	[−0.08,.30]
M_2(R.SEC)	—	—	—	—	—	—	.49(0.11)	<0.001	[.26,.72]	.05(0.12)	.680	[−0.19,.30]
M_3(R.INTERN)	—	—	—	—	—	—	—	—	—	.42(0.14)	.006	[.13,.72]
	R^2=0.2852 $R^2_{X\times W}$ = 0.0965			R^2=0.3502 $R^2_{X\times W}$ = 0.0005			R^2=0.5620 $R^2_{X\times W}$ = 0.0767			R^2=0.7361 $R^2_{X\times W}$ = 0.0098		
	$F(3,37)$=4.92, p=.006			$F(4,36)$=4.85, p=.003			$F(5,35)$=9.98, p<.001			$F(6,34)$=15.81, p<.001		

Note: See Table 1 for factor definitions. N = 41.

Table 3
Model coefficients for phase 2 group trust.

	M_1:ACCEPT			M_2:G.SECURITY			M_3:S.MERGE			Y:TRUST		
	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*
Constant	−0.12(0.13)	.359	[−0.38,.14]	−0.13(0.19)	.465	[−0.51,.24]	.22(0.15)	.146	[−0.08,.53]	5.45(0.13)	<0.001	[5.18,5.71]
X (DDM)	.56(0.13)	<0.001	[.32,.81]	.04(0.22)	.848	[−0.40,.49]	.09(0.18)	.607	[−0.27,.45]	.05(0.15)	0.741	[−0.25,.35]
W (SANCT)	.37(0.21)	.092	[.06,.80]	.35(0.31)	.269	[−0.28,.99]	−0.41(0.26)	.116	[−0.93,.11]	−0.04(0.22)	0.850	[−0.50,.41]
XW	−1.00(0.34)	.005	[−1.68,−0.32]	−0.64(0.53)	.337	[−1.72,.44]	−0.20(0.43)	.654	[−1.08,.69]	.10(0.37)	0.798	[−0.65,.84]
M_1(ACCEPT)	—	—	—	.99(0.23)	<0.001	[.51,1.47]	.11(0.23)	.625	[−0.35,.58]	−0.09(0.19)	0.660	[−0.48,.31]
M_2(G.SEC)	—	—	—	—	—	—	.78(0.13)	<0.001	[.51,1.05]	.80(0.16)	<0.001	[.48,1.12]
M_3(S.MERGE)	—	—	—	—	—	—	—	—	—	.38(0.14)	0.011	[.09,.67]
	R^2=0.5539	$R^2_{X\times W}$ = 0.1067	R^2=0.6268	$R^2_{X\times W}$ = 0.0148	R^2=0.7392	$R^2_{X\times W}$ = 0.0015	R^2=0.8797	$R^2_{X\times W}$ = 0.0002				
	F(3,37)=15.32, p<.001	F(4,36)=15.11, p<.001	F(5,35)=19.84, p<.001	F(6,34)=41.44, p<.001								

Note: See Table 1 for factor definitions. N = 41.

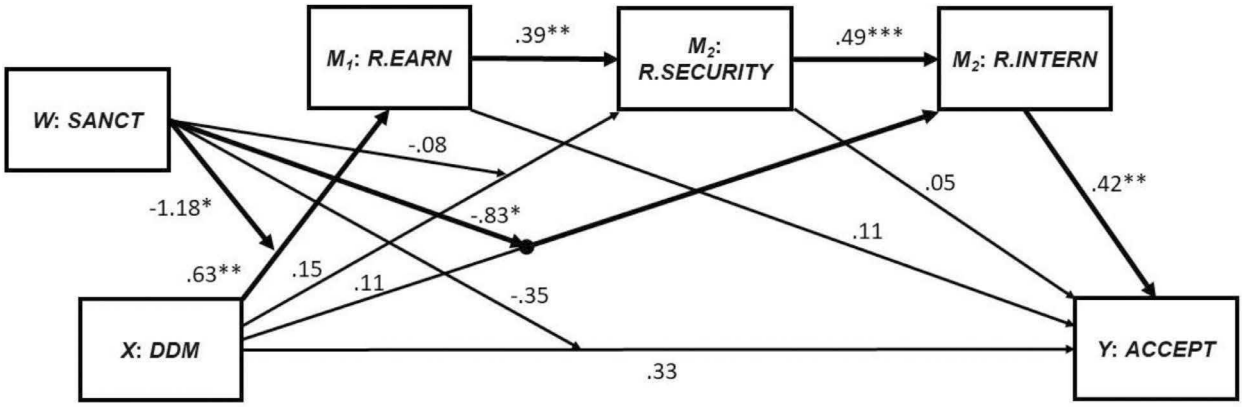

Fig. 5. Path Model: Group Rule Acceptance.
See Table 1 for factor definitions. Indirect effects bolded. $N = 41$. $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

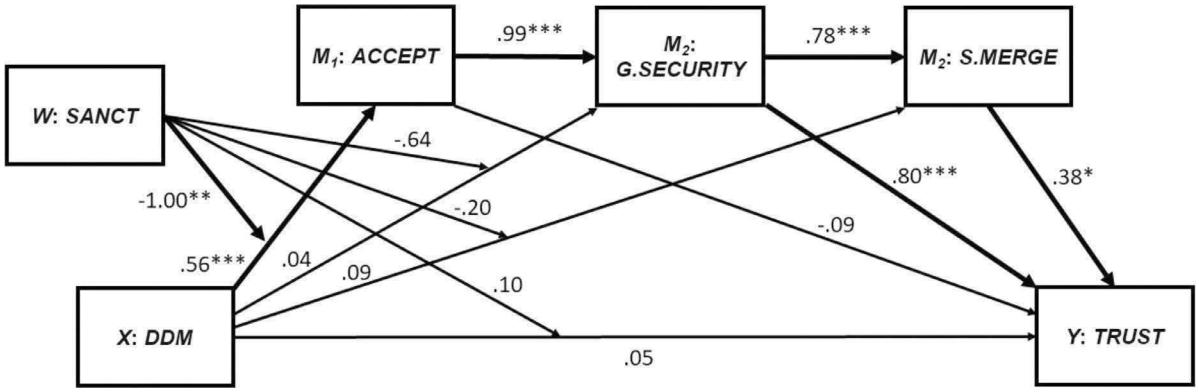

Fig. 6. Path Model: Phase 2 Group Trust.
See Table 1 for factor definitions. Indirect effects bolded. $N = 41$. $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

Table 4
Model coefficients for phase 3 voluntary cooperation (Group Harvests).

	M_1:ACCEPT			M_2:TRUST			Y:COOP		
	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*	Coeff(*SE*)	*p*	*95CI*
Constant	-0.12(.13)	.359	[-.38,.14]	-0.05(.25)	.839	[-.55,.44]	318.48(21.28)	<.001	[275.27,361.68]
X (DDMI)	0.56(.13)	<.001	[.32,.81]	0.13(.29)	.652	[-.45,.72]	2.64(25.02)	.916	[-48.14,53.43]
W (SANCT)	0.37(.21)	.092	[.06,.80]	0.19(.41)	.652	[-.65,1.02]	71.20(35.81)	.055	[-1.50,143.89]
XW	-1.00(.34)	.005	[-1.68,-.32]	-0.68(.71)	.337	[-2.10,.74]	39.50(61.42)	.524	[-85.20,164.20]
M_1(ACCEPT)	—	—	—	1.05(.31)	.002	[.42,1.67]	-12.89(30.64)	.676	[-75.09,49.30]
M_2(TRUST)	—	—	—	—	—	—	48.43(14.42)	.002	[19.16,77.70]
	R^2=.5539, R^2_{XW}=.1067			R^2=.5146, R^2_{XW}=.0128			R^2=.4736, R^2_{XW}=.0062		
	$F(3,37)$=15.32, p<.001			$F(4,36)$=9.54, p<.001			$F(5,35)$=6.30, p<.001		

Note: See Table 1 for factor definitions. N=41.

use of positive social sanctions (*SANCT*: $r = 0.49$), rule acceptance (*ACCEPT*: $r = 0.47$), and trust (*TRUST*: $r = 0.63$). For simplicity, we therefore focus on these factors.

According to HRCT, participants' acceptance of the group conservation agreement and the trust they developed during Phase 2 (Communication) should persist. Greater trust should then increase voluntary cooperation during Phase 3 (No Communication). Results were consistent with this prediction (Table 4, Fig. 7). Overall, the model accounted for 47.36% of the variance in voluntary cooperation and resource sustainability. The previously noted *DDMI* × *SANCT* interaction on rule acceptance (ACCEPT) was mediated by trust. Specifically, once the interaction was accounted for, acceptance emerged as a significant predictor of TRUST ($B = 1.05$, p=.002; *95%CI*[0.42,1.67]). Trust also emerged as a predictor of voluntary cooperation ($B = 48.43$, p=.002; *95%CI*[19.16,77.70]).

Furthermore, the hypothesized pathway linking democratic decision making and social sanctions to voluntary cooperation via acceptance and trust was significant: *DDMI* × *SANCT* → *ACCEPT* → *TRUST* → *COOP* (*Index*=−50.76; *95%CI*[−127.40,−1.37]). These relationships persisted when controlling for each group's conservation agreement (*ns*), Phase 1 trust (*ns*), and Phase 1 harvest rates (*ns*) (preliminary analyses). There was no discernable relationship between specific agreements and coop-

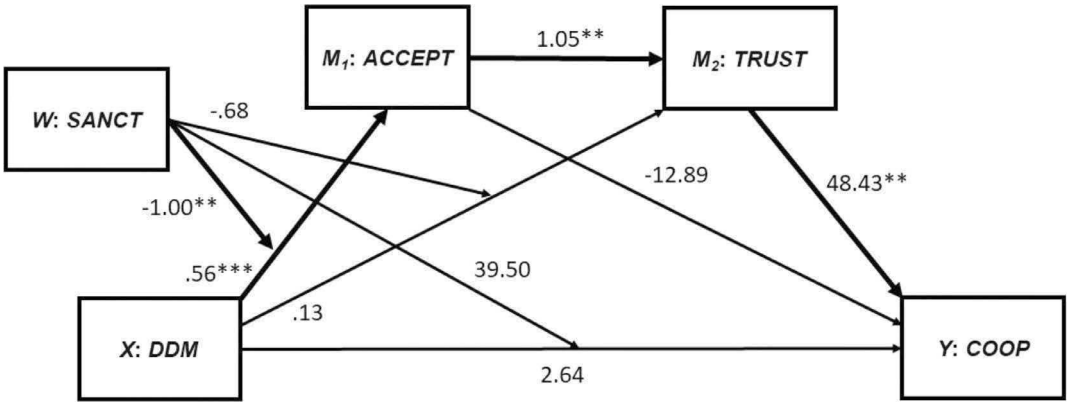

Fig. 7. Path Model: Phase 3 Group Voluntary Cooperation.
See Table 1 for factor definitions. Indirect effects bolded. $N = 41$. $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

eration during Phase 3 (or Phase 2).[4] Hence what mattered most was how those agreements were decided. Overall, these results indicate that groups were more likely to cooperate voluntarily during Phase 3 if they made decisions democratically and enforced their decisions primarily with positive social sanctions (i.e., praise).

6.7. Motivations for self-governance

The previous analyses demonstrated that most groups successfully self-governed, devising effective cooperative agreements and enforcement mechanisms to manage the resource. We now examine participants' construal of the social dilemma and goals for communication, to further clarify participants' motivations for self-governance. We also conduct a follow-up analysis examining change in basic need satisfaction from Phase 1 to 2 to further demonstrate the likely involvement of basic needs in motivating self-organization.

Problem Construal. Rational choice theory assumes that participants primarily regard social dilemmas as competitions to be won and that communication is "mere cheap talk," in which narrowly self-interested individuals deceive one another for exclusive economic gain (Hobbes, 1651/1947; cf. Ostrom et al., 1992). This assumption does not accurately describe participants' apparent construal of the situation. When asked what was going well during Phase 1, only 26% of the responses celebrated selfish behavior (e.g., "I'm usually winning in my group"). The other responses said that nothing was going well. When asked what was going poorly, 73% of the responses mentioned poor cooperation, resource collapse, and inequities (e.g., "People are getting too greedy. if we farmed the tokens, then we all will get more money"). These findings suggest that participants were more focused on promoting cooperation and equity than celebrating or pursuing their own selfish behavior.

Communication Goals. Similarly, of the 17 communication goals assessed, participants most strongly endorsed cooperation, building trust, developing agreements, improving everyone's earnings, and satisfying their needs (e.g., security, competence, equity) (*M*s≥5.97, *range:* 5.97, 6.50). Punishing others ($M = 2.85$, SD=1.96) and deception ($M = 1.93$, SD=1.62) were not strongly endorsed (Table A.6).

Perceptions of the Dilemma Before/After Communication. Table 5 presents perceptions of the dilemma and basic need satisfaction before/after communication. As anticipated, before communication (Phase 1), groups felt that the dilemma was managed poorly (e.g., high chaos, low resource management, low cooperation). They also felt low perceived behavioral control, equity, belonging, and security. Group members felt socially distant (low self-other merging) and low trust. Every factor improved substantially after communication (Phase 2), *Fs*(1,40)≥158.11, *ds*≥1.32, *ps*<0.001).

Basic Need Satisfaction Before/After Communication. HRCT predicts that individuals are motivated to self-govern to improve fundamental needs threatened by poorly governed social-ecological dilemmas. If so, then deficits to participants' fundamental needs during Phase 1 of the experiment (prior to communication) should correlate with Communication Goal 17, their self-reported goal to use communication to, "Come to an agreement about how to manage the tokens as a group." Additionally, basic need satisfaction should be improved with good governance (i.e., democratic decision making with enforcement).

First, consistent with HRCT, lower control (*Perceived Behavioral Control:* $r(39)=-0.32$, $p=.044$), security ($r(39)=-0.43$, $p=.005$), and equity ($r(39)=-0.42$, $p=.006$) during Phase 1 were associated with greater endorsement of the goal to form conservation agreements to manage the resource together. Deficits to groups' belonging ($r(39)=-0.26$, $p=.098$) and competence (*Perceived Behavioral Capability:* $r(39)=-0.19$, $p=.236$) did not reach statistical significance. Hence, belonging needs and competence were not related to motivation to form agreements in this situation, contrary to HRCT's prediction.

Second, to test the assumption that basic need satisfaction is improved with good governance, we conducted a process analysis, examining improvement in need satisfaction before/after communication as a function of HRCT's key factors (i.e., *DDMI* × *SANCT, ACCEPT, TRUST*). Overall perceptions of the dilemma (see *Overall,* Table 4) were strongly correlated with basic need satisfaction (e.g., security, equity), as well as the other perceptions (e.g., chaos, trust): *rs*(*39*)≥.64, *ps*≤.001. Therefore, we used the overall perception items (Phase 1, 2) as proxies for change in need satisfaction (i.e., Phase 2 *Overall* minus Phase 1 *Overall*) in these analyses.

This model accounted for 61.38% of the variance in improvement in groups' basic need satisfaction from Phase 1 to 2. As expected, there was a significant *DDMI* × *SANCT* interaction ($B = 2.58$, $p=.015$; *95CI*: 0.53,4.62). Negative social sanctions were associated with lower need satisfaction, specifically in less democratic groups (Figure A.7). Acceptance ($B = 1.36$, $p=.010$; *95CI*: 0.34,2.38) and trust ($B = 0.89$, $p<.001$; *95CI*: 0.41,1.37) were also important predictors. Finally, two significant pathways emerged, linking the *DDMI* × *SANCT* interaction to overall need satisfaction: a pathway via rule acceptance (*Index*=−1.36; *95%CI*[−3.24,−0.01]), and a pathway via rule acceptance and trust (*Index*=−0.94; *95%CI*[−2.22,−0.04]). These findings are consistent with

[4] This is true whether we parse the rules in terms of private property (32 groups, 78%) versus "other" strategies (8 groups, 22%), $F(1,39)=0.15$, $p=.705$, $\eta^2=.00$; or pure private property "only" (4 groups, 10%), private property "plus other" strategies (e.g., private property plus delayed harvest; 22 groups, 54%), versus "other" strategies (22%), $F(2,38)=1.87$, $p=.169$, $\eta^2=.09$.

Table 5
Perceptions of dilemma, needs, and group cognitions before/after communication.

	Phase 1 *M(SE)*	Phase 2 *M(SE)*	Significance Test (Effect Sizes)
Dilemma			
Chaos	5.19(0.15)	2.16(0.14)	$F(1,40)=184.19$, $\eta^2 = 82\%$, $d = 2.11$
Resource Management	2.75(0.15)	6.13(0.12)	$F(1,40)=223.53$, $\eta^2 = 85\%$, $d = 2.33$
Cooperation	2.45(0.12)	6.13(0.12)	$F(1,40)=398.22$, $\eta^2 = 91\%$, $d = 3.12$
Overall	3.18(0.16)	6.14(0.14)	$F(1,40)=174.24$, $\eta^2 = 81\%$, $d = 2.06$
Needs			
Behavioral Control	3.52(0.11)	5.96(0.12)	$F(1,40)=162.70$, $\eta^2 = 80\%$, $d = 1.99$
Security	3.12(0.12)	5.84(0.12)	$F(1,40)=195.55$, $\eta^2 = 83\%$, $d = 2.19$
Equity	3.20(0.24)	5.86(0.16)	$F(1,40)=158.11$, $\eta^2 = 80\%$, $d = 1.32$
Belonging	3.05(0.25)	5.66(0.14)	$F(1,40)=204.20$, $\eta^2 = 84\%$, $d = 1.38$
Group Cognitions			
Trust	2.51(0.12)	5.43(0.14)	$F(1,40)=218.55$, $\eta^2 = 85\%$, $d = 2.30$
Self-Other Merging	2.97(0.12)	5.44(0.12)	$F(1,40)=215.90$, $\eta^2 = 84\%$, $d = 2.31$

Phase 1 (no-communication baseline). Phase 2 (communication). 7-point response scale. All tests (Repeated Measures ANOVAs) significant, $p<.001$. $N = 41$.

HRCT's assumption that fundamental needs drive self-governance motivation.

7. Discussion

Hobbes (1651/1947) and Hardin (1968) famously stated that communication ("mere cheap talk") is useless in social-ecological dilemmas and that self-governance inevitably yields tragedy. These claims continue to dominate science and public policy, because a compelling alternative to rational choice theory's narrow concept of self-interest has not emerged (Miller, 1999; Ostrom, 1998, 2010a). Humanistic Rational Choice Theory (HRCT; DeCaro, 2018, 2019) addresses this gap by framing self-interest in the context of core human needs and social cognitions, and acknowledging people's drive for self-agency and conditional cooperation (cf. Ryan and Deci, 2017a; Van Vugt, 2009). This drive compels individuals to cooperatively self-govern to resolve dilemmas that threaten their interdependent needs. Moral sentiments associated with procedural justice, belonging, and equity temper narrow self-interest (Bowles, 2008; Smith, 2010). These features of human nature create a basic preference for fair, autonomy-supportive governance systems that can support altruistic behavior (Ostrom, 2003).

HRCT's predictions were borne out in the current experiment. After collapsing the resource in Phase 1, participants were more likely to report goals to cooperate than to maintain self-interest. Participants also reported deficits to fundamental needs, such as security, belonging, equity, and perceived behavioral control (i.e., efficacy, controllability). Participants indicated that they wanted to use communication specifically to improve these deficits.

When given the opportunity to communicate during Phase 2, most groups self-governed. They created conservation agreements to reverse environmental degradation and improve everyone's welfare. Democratically governed groups exhibited the greatest cooperation and continued to cooperate even after communication ended (Phase 3). As anticipated, these groups satisfied their needs better, accepted their agreements more, and developed greater trust, accounting for 47% of the variance in Phase 3 voluntary cooperation.

Groups that primarily used positive social sanctions (e.g., praise) to enforce their agreements, and justified (i.e., legitimized) negative social sanctions (e.g., threats) by making decisions democratically, reported higher rule acceptance and trust. Higher rule acceptance and trust indicates that these groups established more robust social contracts. These social contracts endured voluntarily in Phase 3 without continued enforcement. By contrast, negative sanctions backfired in undemocratic groups, failing to establish strong social contracts capable of sustaining cooperation or resource sustainability during Phase 3.

The current experiment allowed participants to govern themselves over several periods of time, across multiple phases. During Phase 2, there was a sharp increase in cooperation with communication, alongside increases to fundamental needs and social cognitions. We are not able to strongly claim causal links among these factors, because the quality of communication (e.g., democratic decision making) was a naturally occurring process, not tightly controlled or manipulated in the current experiment. Moreover, there is very likely reciprocal causation occurring (as predicted by HRCT; Fig. 1: Feedback Loop), as virtuous cycles of good governance, need satisfaction, trust, and conditional cooperation developed throughout Phase 2.

For example, it possible that rule acceptance and trust emerged simultaneously from democratic decision making and enforcement, rather than sequentially. We believe this possibility is unlikely because prior research suggests trust emerges most strongly from observed trustworthy behavior (e.g., altruistic acts) by initial cooperators, who internalize and accept cooperation with the rules/agreements (e.g., Bendtsen et al., 2016; Gächter, 2007; Milinski et al., 2002; Tyler et al., 1985; cf. DeCaro et al., 2015; Ostrom, 1990, 2003). There also was no parallel, significant direct relationship between *DDM* × *SANCT* and Trust after accounting for the effect of democratic decision making and enforcement on acceptance (see Figs. 6,7).

Our model of rule acceptance suggests a potential refinement in our understanding of institutional acceptance. Specifically, neither *R.EARN* (perceived individual earning potential of the rule/agreement) nor *R.SECURITY* (perceived security potential of the rule/agreement) had direct paths to rule acceptance. Additionally, the strongest path was *DDM* × *SANCT* → *INTERN* → *ACCEPT*. Removing *R.EARN* and *R.SECURITY* from the model for rule acceptance does not decrease the overall model fit (R^2=73%). This finding suggests these factors may not be centrally important for formation of acceptance, in the current situation. However, if we instead assume individuals are seeking to optimize equity, model fit improves by 15% (R^2=88%), and the following (marginally-significant) pathway emerges: *DDM* × *SANCT* → *INTERN* → *EQUITY* →*ACCEPT* (*Index*=−0.19; *95%CI*[−0.44,0.03]). Hence, individuals may accept social contracts that match their core values/desires and improve equity. The latter finding is consistent with numerous studies that found equity is a strong motive for cooperation (e.g., Dawes et al., 2007; Fehr and Gächter, 2002; Henrich et al., 2005; Janssen, 2010; Orbell et al., 1988; Ostrom, 1990; Pavitt, 2011).

Finally, extensive research in other domains has consistently demonstrated that fair decision-making procedures often precede subsequent need satisfaction, followed by rule internalization and acceptance (cf. De Cremer and Tyler, 2005; Ryan and Deci, 2017b; Tyler, 2006). For example, DeCaro et al.'s (2015) experiment tightly manipulated voting

procedures before Phase 1 to observe the effect of a single vote on subsequent motivations and perceptions, immediately after the vote and at the end of Phase 2 (tracking change over time). The effects observed in the current experiment are consistent with this sequence. Although we suspect that the observed social-psychological processes are causally related, future research will need to carefully, temporally tease these dynamics apart. The current study achieved its primary goal to demonstrate the likely involvement of fundamental needs and cognitions in cooperative self-governance.

8. Communication in environmental governance

The findings of the current experiment mirror effective environmental governance systems observed worldwide (e.g., Cox et al., 2010; Epstein, 2017; Kubo and Supriyanto, 2010; Ostrom, 1990; Turner et al., 2014). They also highlight an important point: societies and well-maintained ecological systems exist because of social contracts (e.g., rules, norms, agreements; Ostrom, 1998). These contracts are created and sustained by communication (Ostrom, 1980; 1994; Ostrom et al., 1992). Our results affirm the basic democratic principle that robust social contracts are decided using contextually appropriate, fair/autonomy-supportive collective choice procedures (DeCaro and Stokes, 2013; Gibson, 1989; Ostrom, 1994). This principle is illustrated by social dilemma research (e.g., DeCaro et al., 2015; Epstein, 2017; Hilbe et al., 2014; Markussen et al., 2014; Ostrom, 1990; Tyran and Feld, 2006; Van Vugt et al., 2004; Vollan, 2008; Vyrastekova and van Soest, 2003; Yamagishi, 1986). Communication and collective choice procedures that undermine stakeholders' procedural justice and self-determination often undermine ecological sustainability (DeCaro et al., 2017a; Ostrom, 2000).

Public policy based on rational choice theory (RCT) marginalizes citizens' role in governance (Ostrom, 2010a), because RCT assumes people are narrowly self-interested and extrinsically motivated to cooperate (Becker, 1974; Hobbes, 1651/1947; cf. Ostrom, 2010b). RCT justifies benevolent dictators and coercive, centralized regimes, which attempt to force unwilling agents to cooperate (Bowles, 2008; Miller, 1999; Ostrom, 2010a). Enforcement is necessary, but strict enforcement has limitations (Bowles, 2008; Ostrom et al., 2007). Participants in the current experiment could effectively enforce their conservation agreements using praise and limited negative sanctions, because they were in tight networks with near perfect ability to establish positive reputations and monitor everyone's behavior (Galbiati et al., 2018; Milinski et al., 2002; cf. Ostrom, 1990; Rand et al., 2009,2014). However, even in this simple context, we demonstrated that enforcement must be legitimized to be truly effective. It is an overgeneralization to assume that unwilling defectors can simply be forced to cooperate by enforcement alone (Gibson, 1989; Tyler, 1990). Unjustified enforcement failed to stop defection and undermined rule acceptance, making continued enforcement more costly and less useful (cf. Bowles, 2008; Cardenas et al., 2000; Chen et al., 2009; Epstein, 2017; Ostrom, 2000; Vyrastekova and van Soest, 2003).

With these insights, HRCT reconceptualizes self-interest and the role of the State in environmental governance. Whereas RCT assumes ecological systems must be coercively protected from people (Ostrom, 1990, 2010a), HRCT (DeCaro, 2018, 2019) assumes ecological systems can be protected with people (DeCaro and Stokes, 2013). According to HRCT, a government's role is to facilitate self-organization and cooperation in three ways: (a) cultivating norms of cooperation, sustainability, and resilience, (b) enforcing basic rights for fair societal decision-making procedures, and (c) providing both opportunity and formal authority, responsibility, and resources (e.g., education, funding), for widespread communication and collaborative problem-solving (DeCaro et al., 2017b). Such "state-reinforced self-governance" (Sarker, 2013) arguably better aligns with human nature, and provides more effective and adaptive governance of ecological systems (e.g., Lubell et al., 2020; cf. Dietz et al., 2003).

9. Contextual factors (Institutional fit) influencing fundamental needs

We have focused on the brighter sides of human nature, as a much-needed contrast to the traditional narrative of RCT (cf. Ostrom, 1998, 2010a; Ryan and Deci, 2017a). However, altruism is not assured. People can be devious and uncooperative. Governance systems can facilitate cooperation. However, effective governance systems are difficult to design, because people and social-ecological systems are diverse (Ostrom et al., 2007). HRCT provides guidance on this issue. Fundamental needs are ubiquitous, affecting all people (Baumeister and Leary, 1995; Deci and Ryan, 2000). But they are also culturally and contextually subjective (Chen et al., 2015; Rudy et al., 2007). Fundamental needs must be satisfied in contextually appropriate ways (see *psychosocial fit*, Fig. 3; cf. DeCaro and Stokes, 2013).

For example, individuals in individualistic cultures (e.g., United States) generally emphasize individual autonomy and, therefore, typically perceive decision procedures that give individuals direct choice as fairer. Collectivistic cultures (e.g., China, Japan) typically emphasize more inclusive forms of autonomy, often perceiving decision procedures that grant trusted authority figures (e.g., elders, parents, bosses) more decision control as fairer (e.g., Rudy et al., 2007). Enforcement effects are also contextual. For example, a field experiment in two regions of Africa found that voting with enforcement (economic sanctions) increased cooperation in groups with historically low trust but decreased cooperation in groups with high prior trust (Vollan, 2008). Group polarization and community dynamics, such as racial and wealth disparities, can also alter the effects of communication, decision-making, and enforcement (Cardenas et al., 2000; DeCaro et al., 2017a; Hackett et al., 1994; Meinzen-Dick, 2007).

Good governance, therefore, requires a firm grasp of people's perceptions in particular social-ecological settings (Anderies et al., 2011; Weber et al., 2004). The participants in our experiment were predominantly U.S.-born citizens, with a Western democratic background and particular norms of decision fairness. Hence, our participants tended to create democratic, self-governing systems that specifically supported both individual and collective choice—and perceived these systems as fairer (DeCaro et al., 2020; van Prooijen, 2009). Individuals with different backgrounds may have devised different governance systems (Ostrom, 2005). Our research suggest that what matters is that those systems be perceived as fair.

Conclusion

Public policy based on RCT has benefited human civilization. However, classical RCT over-emphasizes people's selfishness and ignores their capacity for cooperation and self-governance. This narrow interpretation of human nature is a barrier to modern welfare, perpetuating myths that create misguided public policies, which decrease cooperation and exacerbate society's most pressing social-ecological dilemmas (Miller, 1999; Ostrom, 2010a). RCT needs to acknowledge the brighter aspects of self-interest, to provide a better theoretical and scientific foundation for human governance—one that not only prevents defection, but more importantly, cultivates humanity's propensity for collective altruism (Bowles, 2008; Ostrom, 1998, 2000). The next generation of RCT must begin with the core needs and social cognitions that fundamentally energize human behavior (DeCaro, 2018, 2019; Ostrom, 2010b; Ryan and Deci, 2017a). The best way to achieve this goal is to begin to assess individuals' self-expressed goals in social dilemmas, as well as their motivations and perceptions. These sentiments should inform next-generation theories of cooperative behavior.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Daniel A. DeCaro: Project administration, Funding acquisition, Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. **Marco A. Janssen:** Project administration, Funding acquisition, Conceptualization, Resources, Writing – review & editing. **Allen Lee:** Funding acquisition, Methodology, Software, Data curation, Writing – review & editing.

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Supplementary materials

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