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Opinion

Situational social influence leading to non-compliance with conservation rules

William N.S. Arlidge [1,*], Robert Arlinghaus [1,2,3], Ralf H.J.M. Kurvers [1,3,4], Anne Nassauer [5], Rodrigo Oyanedel [6,7] and Jens Krause [1,2,3]

It is well established that the decisions that we make can be strongly influenced by the behaviour of others. However, testing how social influence can lead to non-compliance with conservation rules during an individual's decision-making process has received little research attention. We synthesise advances in understanding of conformity and rule-breaking in individuals and in groups, and take a situational approach to studying the social dynamics and ensuing social identity changes that can lead to non-compliant decision-making. We focus on situational social influence contagion that are copresent (i.e., same space and same time) or trace-based (i.e., behavioural traces in the same space). We then suggest approaches for testing how situational social influence can lead to certain behaviours in non-compliance with conservation rules.

Highlights

The study of social influence that can lead to non-compliance with conservation rules has primarily been operationalised by understanding peoples' predispositions and perceptions of social norms, situational patterns of occurrence, and how enforcement can affect compliance.

We propose integrating approaches used to study collective behaviour in behavioural ecology and microsociology with current understanding of the cognitive mechanisms underlying rule breaking in order to experimentally test the situational social dynamics and ensuing social identity changes that can lead to non-compliance during decision-making.

Improving our fundamental understanding of how social influence drives non-compliance during decision-making presents substantial opportunities to support research on non-compliance with conservation rules. For example, identifying linear spreading dynamics or quorum thresholds for behaviour change in groups.

Non-compliance with conservation rules

Rules that govern human behaviour are a key component of biodiversity conservation [1,2]. These rules range from spatiotemporal restrictions that limit access to natural resources using protected areas or seasonal closures [3,4], to constraints on resource extraction using harvest quota or size limits [5,6], to international regulations and laws protecting natural habitats and species (e.g., the Convention on Biological Diversity [7]). However, **non-compliance** (see Glossary) with conservation rules occurs frequently, and can have wide-ranging impacts on socioecological systems and the populations therein [8,9]. The illegal take of seafood from marine protected areas, for instance, can render conservation actions ineffective [10,11]. Even minor infractions can ultimately result in severe outcomes when people imitate the behaviour of other rule breakers. For example, hikers leaving waymarked trails in protected areas can lead to littering, trampling of protected flora, fauna, and funga, and occasionally human deaths [12,13].

Reducing and preventing non-compliance can contribute to securing livelihoods, food security, public safety, and the conservation of biodiversity [9]. Nonetheless, conservation interventions routinely fail to properly account for, and respond to, acts of non-compliance [11,14]. One potentially contributing factor to this, is the lack of understanding of how social influence – individuals' tendency to conform to the beliefs and attitudes of others – contribute to people's decision-making processes of rule compliance. The **situational social influence** processes that are occurring as non-compliant decision-making takes place have rarely been quantitatively and experimentally tested, and few attempts have been made to integrate insights from disciplines studying the cognitive mechanisms and social dynamics related to social conformity and rule violations in groups such as cognitive psychology, microsociology, and behavioural ecology [15,16].

Non-compliance is a broad term that encompasses several related issues. For one, the literature on resistance to conservation has developed important insights for our understanding of different

[1]Department of Fish Biology, Fisheries, and Aquaculture, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Müggelseedamm 310, 12587 Berlin, Germany
[2]Faculty of Life Sciences, Humboldt-Universität zu Berlin, Invalidenstrasse 42, 10115 Berlin, Germany
[3]SCIoI Excellence Cluster, 10587 Berlin, Germany
[4]Center for Adaptive Rationality, Max Planck Institute for Human Development, 14195 Berlin, Germany
[5]Faculty of Economics, Law and Social Sciences, University of Erfurt, Nordhäuser Str. 63 99089 Erfurt, Germany
[6]Instituto Milenio en Socio-Ecología Costera (SECOS), Av. Libertador Bernardo O'Higgins 340, Santiago, Región Metropolitana, Chile

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[7]Centro de Investigación en Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL)- Universidad Austral de Chile, Edificio Emilio Pugin, piso 1 Campus Isla Teja, Valdivia, Región de los Ríos, Chile

*Correspondence: william.arlidge@igb-berlin.de (W.N.S. Arlidge).

peoples' attitudes towards conservation rules [17]. Additionally, because of the high diversity of drivers that can lead to different non-compliant behaviours [17–19], there is likely variation in how much situational social influence impacts non-compliant decision making in relation to different drivers (e.g., by the type of conservation rule, contagion modality, or geographic location). For instance, in this article, discussion is focused on non-compliant behaviours that typically lead to relatively minor or moderate consequences, but we believe there is a clear rationale to explore the impact of situational social influence on all non-compliant decision-making processes – including those that are marked by violence or other major consequences.

Here, we present a situational approach to quantitatively and experimentally test social influence processes as non-compliance decision-making takes place. We briefly examine the theory of non-compliance with conservation rules, discuss situational social influence including some of the key contagion modalities, highlight advances in understanding and testing of social influence during decision-making in individuals and in groups, and outline possibilities for data gathering and experimental testing.

Towards a situational approach

The non-compliance literature has primarily focused on understanding people's predispositions and personal motivations to comply with rules, and on the role of the immediate environment in the occurrence of non-compliance [18]. Research testing people's personal motives for non-compliance tends to leverage economic and psychological theories on rule-breaking. For example, the instrumental model, which is based on Becker [20], was developed to frame people's internal calculation of the potential costs and benefits of non-compliant behaviours (i.e., instrumental motivations). People's motivations to comply can be further deconstructed into legitimacy-based motivations [21,22] and normative motivations [23–25]. Legitimacy-based motivations such as legitimacy of authorities and equity and effectiveness of rules have been shown to play an important role in non-compliant decision-making [26–28]. By contrast, normative motivations can influence an individual's behaviour through two distinct **social norms**: (i) injunctive norms signalling what others typically approve or disapprove; and (ii) descriptive norms signalling what others typically do or do not do [25,29]. For example, Cialdini *et al.* [29] studied how descriptive norms affect littering behaviour. This study demonstrated, that regardless of the prevailing injunctive norm on antilittering, that participants littered more in a rubbish-scattered environment than in the same environment when it was litter free. There is a growing body of research quantifying how injunctive norms (e.g., guilt, peer disapproval [26,30,31]) and descriptive norms (e.g., perceived non-compliance of others [32,33]) can influence people's motivations for non-compliance.

However, understanding people's personal motivations, such as their predispositions and perceptions of social norms, only forms part of the picture. Research exploring the role that the environment plays in non-compliance has tended to focus on understanding patterns of occurrence [34,35], and exploring how the degree of controls affect compliance [36]. Where these lines of research fall short is in providing an understanding of how social influence processes in the decision-making situation can lead to non-compliance. For this we need to consider situational interactions with, and influences from, other people and the immediate environment. This means testing the situational dynamics of social influence processes occurring immediately preceding, during, and after a possible non-compliance decision and action [15,37,38]. Consider a fisher who is thinking that people typically do not break the rule of no fishing inside their local no-take protected area (i.e., descriptive norm). This fisher might also assume that other people would not approve of people breaking the rule (i.e., injunctive norm). In the immediate situation, however,

the fisher might act in non-compliance because they see several other fishers who are fishing inside a no-take protected area and they are not getting caught (i.e., the fisher's immediate actions are driven by situational social influence).

The spreading dynamics of situational social influence

One of the longest standing enquiries in social influence research remains fundamental to the spread of behaviour in groups – what is the relationship between group conformity and the size of the majority? In psychology, Asch [39,40] explored how a unanimous majority of actors, who were instructed to incorrectly judge the lengths of lines drawn on certain cards, can overtly confront a person's perception. The majority size in a group was found to have little effect beyond three or four people. Subsequently, several theories, including Social Impact Theory [41], mostly disagreed with Asch, reasoning that the larger the size of the majority, the larger the effect [42]. Different models for social conformity at this time were primarily distinguished by the shape of their relationship of group size to conformity. More recently, researchers proposed that the relationship of group size to conformity vary systematically with the task and setting [42]. Collective behaviour research supports this proposal having identified decision dynamics that propagate linearly or by nonlinear **quorum threshold**. For example, clapping in crowds spreads linearly [43], whereas jaywalking pedestrians have been found to move out from a group in a wave-like pattern following a leading individual [44–46]. Nevertheless, how the relationship between group conformity and the size of the majority changes by the type of conservation rule or other drivers remain largely unknown.

One person can be socially influenced from another person or a group of people, so too, can a group of people – resulting in individual non-compliance, and the spread of **collective non-compliance** (Figure 1). One person or a group of people might interact with another person or group (i.e., reciprocal social influence), or they might see a person or group of people perform a behaviour and copy them [47]. Situational social influence can spread between, say, a group of fishers (some of whom might be breaking a rule by fishing in a protected area) to an observing fisher; observer and observed are all in the same physical space and time (**copresent contagion**) (Box 1). More subtly, situational social influence can spread between people through traces that the behavioural decisions that people leave in the environment – a phenomenon known as stigmergy (**trace contagion**) [48,49]. For instance, pedestrians might see traces of other pedestrians in the paths that they create in urban greenspaces (Box 2). Possible sequential effects of non-compliance might result from initial rule-breaking behaviour [50]. For example, if a person is repeatedly subject to situational social influence, they might begin to break or resist that specific rule proactively (i.e., shifting from a follower to a leader). Our underlying assumption is that social influence from localised social interactions and behavioural observations (or traces thereof) can lead to changes in behavioural practices that are incongruous with conservation rules.

A research agenda for situational social influence on non-compliance

Research in cognitive psychology, microsociology, and behavioural ecology have advanced our understanding of the cognitive mechanisms and social dynamics that underlie social conformity and rule violations in groups [15,51,52]. Social psychological research, for instance, suggests that in groups, compliance with rules tends to be the norm, and acts of non-compliance can cause individual cognitive conflict [53]. If a person, alone or in a group, is aware of a rule and encounters other people breaking it, social groups and societal rules can apply opposing forces of social influence. These opposing forces can drive people to conform with the rule-breaking group rather than follow the rule [40,54].

Normative social influence, where individuals conform to the group to gain social approval, and informational social influence, where people accept information from others as adequate

Glossary

Collective non-compliance: self-organised grouping behaviour violating rules for biodiversity conservation that emerge from the rapid transfer of information among group members and their environment.
Copresent contagion: more generally, refers to the spread of something (e.g., behaviours, attitudes, emotions, or information) through a social network when a person is in the same space and time as one or more other people. Situational social influence via copresent contagion occurs when social influence processes are exerted on a person or group of people from another person or group in the same space and time.
Non-compliance: violations of rules for biodiversity conservation or natural resource management (can also be referred to as environmental non-compliance).
Quorum threshold: the number of individuals (here, people) in a group, which once reached, will initiate copying in other group members.
Situational social influence: refers to interactions, observations, and decision-making of the person between their copresence with other people and their action of interest (e.g., non-compliance), or their physical copresence with traces left by a previous person or people and their action of interest. Situational social influence processes can include a wide and complex number of factors such as interactions, attention, the number of people, who the people are, authority levels, and proximity.
Social norms: rules or standards that are understood by members of a group, and that guide and/or constrain social behaviour with or without the force of law. Social norms are often separated into injunctive norms, signalling others' (dis)approval, and descriptive norms, signalling prevalence.
Trace contagion: situational social influence via trace contagion occurs when a person is subject to social influence from others but is spatially removed them. For example, someone sees traces in the environment that a rule violation has occurred without seeing someone violate a rule in the same space and time.

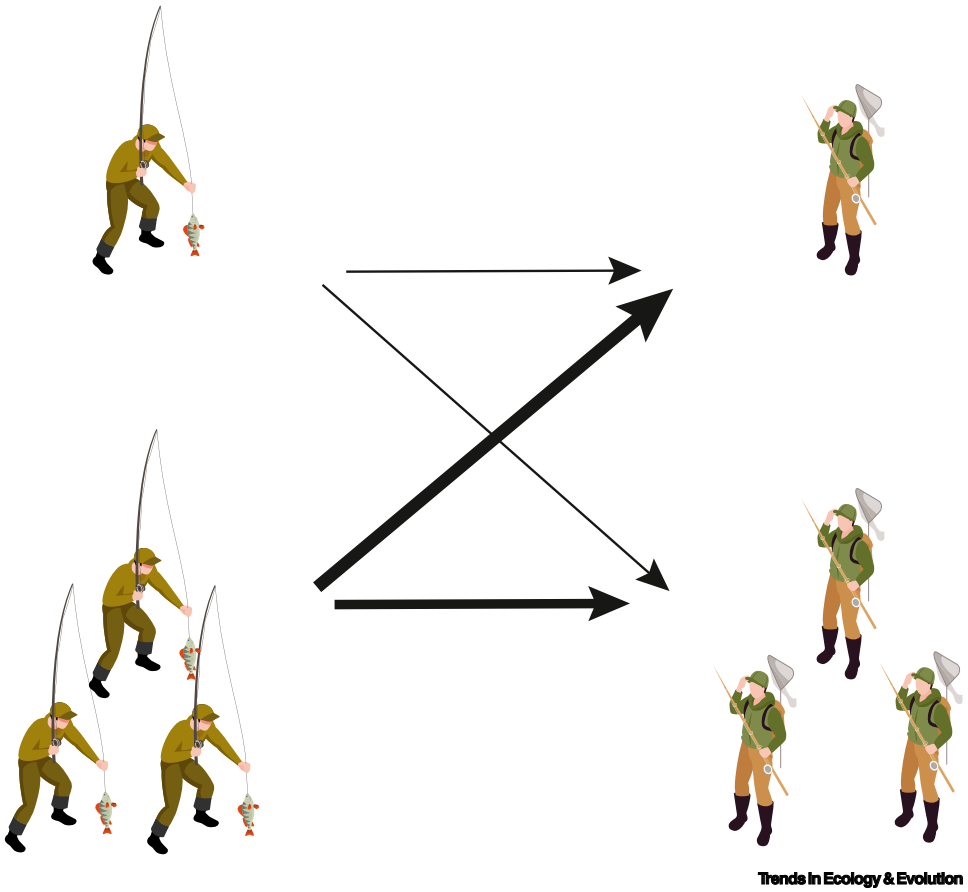

Figure 1. Situational social influence on individual or collective non-compliance. Noncompliers are shown as fishers (left side) who are illegally harvesting fish in a Marine Protected Area (MPA) – not shown. Observers are fishers standing outside the MPA (right side). Arrows indicate situational social influence in every direction. While compliers can also have situational social influence on other compliers, this article is focused on social influence processes leading people to non-compliance. The arrows are one-directional to reflect this research interest. Within-group situational social influence processes can influence the strength of the between-group situational social influence, but arrows for within-group situational social influence processes are not shown here. The hypothesised strength of the situational social influence from noncompliers to observers is predicted to be weakest between the individual noncomplier (top left) and observer (top right), followed by the noncomplying group (bottom left) and the observing group (bottom right) [44–46,76]. Situational social influence processes are hypothesised to be strongest between the noncomplying group (bottom left) to the observing person (top right) [44]. Figure created by W.N.S.A. using images from macrovector on Freepik.com.

representations about reality and therefore conform [54,55], interact when decisions are made in groups [56]. The integration of informational social influence has been demonstrated to be particularly relevant in the context of non-compliance in groups [57,58]. Different cognitive processes can be involved in the interrelated processes of rule breaking, social influence, and group conformity [15]. Research from cognitive psychology demonstrates that some of the key cognitive mechanisms underlying rule-breaking behaviour include motor processes [59,60], perceptual and attentional processes [61], evaluative processes [55,62], and asymmetrical learning rates [63] (Figure 2).

However, investigations of conformity from social psychology and cognitive psychology have been dominated by static social influence environments, lacking the dynamic properties that characterise the situational dynamics of social influence processes that can lead to individual

Box 1. Copresent and trace contagion – a case study of illegal fishing

Let us consider the frequent harvest tactic of fishing the line, which is a practice of concentrating fishing effort at the boundary of a no-take Marine Protected Area (MPA) [95]. Fishing the line is based on the principle of the net export of stock from the protected area to the surrounding unprotected waters (i.e., the spillover effect) [96]. In this scenario, an individual fisher (Figure IA) stands just outside the edge of a no-take MPA where they observe either an individual fisher or a group of fishers (the latter shown opaquely) illegally harvesting inside the no-take fishing zone. Next, a group of fishers (Figure IB) stand outside the MPA and observe another group of fishers' illegally harvesting inside the MPA (an example of how collective non-compliance might emerge). Critically, contagion properties of social influence change as the size of the group changes [71]. Last, an individual fisher (Figure IC) or a group of fishers (Figure ID) standing outside the MPA see evidence that non-compliance has occurred in the form of discarded fishing gear near the water's edge inside the MPA (i.e., situational social influence through trace contagion).

Situational social influence transmitted through trace contagion presents an interesting asymmetry, where a person might not observe others complying with a given rule (e.g., fishing outside the MPA), but they notice traces of non-compliant behaviour having occurred in the environment (e.g., seeing fish guts or discarding fishing gear inside the no fishing zone). These cues can give the illusion that a large proportion of people are violating a rule, whereas in reality this might not be the case. Another asymmetry is that when a person only sees evidence of non-compliance, on the one hand, it might appear easier to break a rule, as there is no one around who sees it. On the other hand, an observer might think that whoever left traces of non-compliant behaviour were fishing when no rangers of enforcement were around, yet they might not be sure if the rangers are present as they decide whether or not to fish inside the MPA.

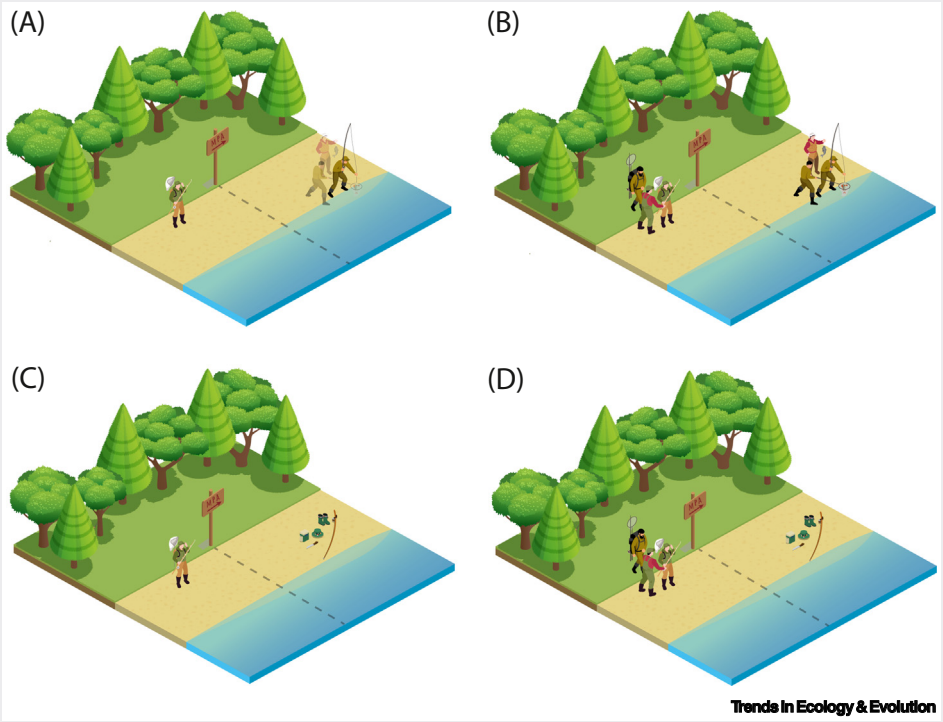

Figure I. Examples of situational social influence through copresent and trace contagion that could potentially lead to illegal fishing in a no-take marine protected area (MPA) – delineated by the broken line. The no-fishing zone is the beach and water area to the right-hand side of line. Figure created by W.N.S.A. using images from macrovector on Freepik.com.

and collective non-compliance [64]. While collective behaviour research has focused on these dynamic properties [43,44,46,65], it has widely neglected the cognitive perspective [15]. Microsociological research presents further evidence that a person's predispositions offer only partial understanding of the explanation of individual and collective behaviour [38,66]. What

Box 2. Predicting human behaviour – a case study of emerging trail systems

Research studying the emergence of trail systems from the late 1990s presents an interesting example of studying social influence processes transmitted through copresent and trace contagion. Helbing *et al*. [97,98] developed an agent-based model for path formation in urban greenspaces. The model took account of the pedestrian agents' angle of perception, velocity of motion, and functions of repulsion and attraction to other pedestrian agents and environmental borders (with monotonically increasing potential – comparable with molecules) [99]. Secondary paths were accurately predicted when shortcuts of a certain magnitude were possible in relation to the distance a pedestrian agent had to travel around a greenspace to get to their destination [97,98]. The model predictions were compared with field observations, and subsequent research was able to replicate the results of the model using an experimental platform with participant trials [100].

This research is particularly powerful because it is model based, and the behaviour predictions were found to be quantitatively accurate when compared with field observations and online experimental participant trials. Beyond a function of monotonically increasing potential as pedestrian agents move closer to one another, situational social influence processes were not integrated into the model. Unanswered questions remain concerning the potential effect of situational social influence processes on spontaneous paths formed by pedestrians (Figure I). For example, we might assume that situational social influence processes are strongest when someone sees someone else leave the official path to take a shortcut, rather than only seeing the evidence that someone has deviated from the path. However, this question remains untested in a quantitative experimental setting. The role that situational social influence processes play in driving certain types of non-compliance with conservation rules might be similarly understood under select prespecified conditions (e.g., understanding and predicting when hikers deviate from waymarked paths in terrestrial protected areas – a behaviour that can damage protected flora, fauna, and funga [12,13]) – thereby improving our understanding of how the behavioural drivers of non-compliant behaviours operate.

Figure I. Examples of trails formed by pedestrians in Treptower Park, Berlin, Germany. Thanks to Joey Bania for taking the photographs used in the figure.

happens *in situ* at the moment of decision-making, including interaction rules among group members, their surrounding environment, and ensuing social identity changes, are thought to play an essential role in both individual and group behaviour [51,52,67].

Models of collective behaviour can help to improve our understanding of how interactions between people lead to group-level behavioural patterns. Of pertinence for studying emerging social behaviours are agent-based models that describe interactions among people and their environment [68], diffusion models to explain observed patterns of choices and response times [69,70], and social network analysis to understand information flow and behaviour change through groups [71,72]. Crucially, certain collective behaviours do not always conform with societal rules [15,73]. Studies modelling collective rule-breaking demonstrate violent outbreaks of civil disorder form when confrontational tensions are overcome [66,74], pedestrians jaywalking at red lights [44], and people leaving waymarked paths and creating new paths in urban greenspaces (Box 2).

Researchers can also consider the ensuing social identity changes following social interactions that might lead to non-compliance. An observer – using the fisher example (Figure 2) – might

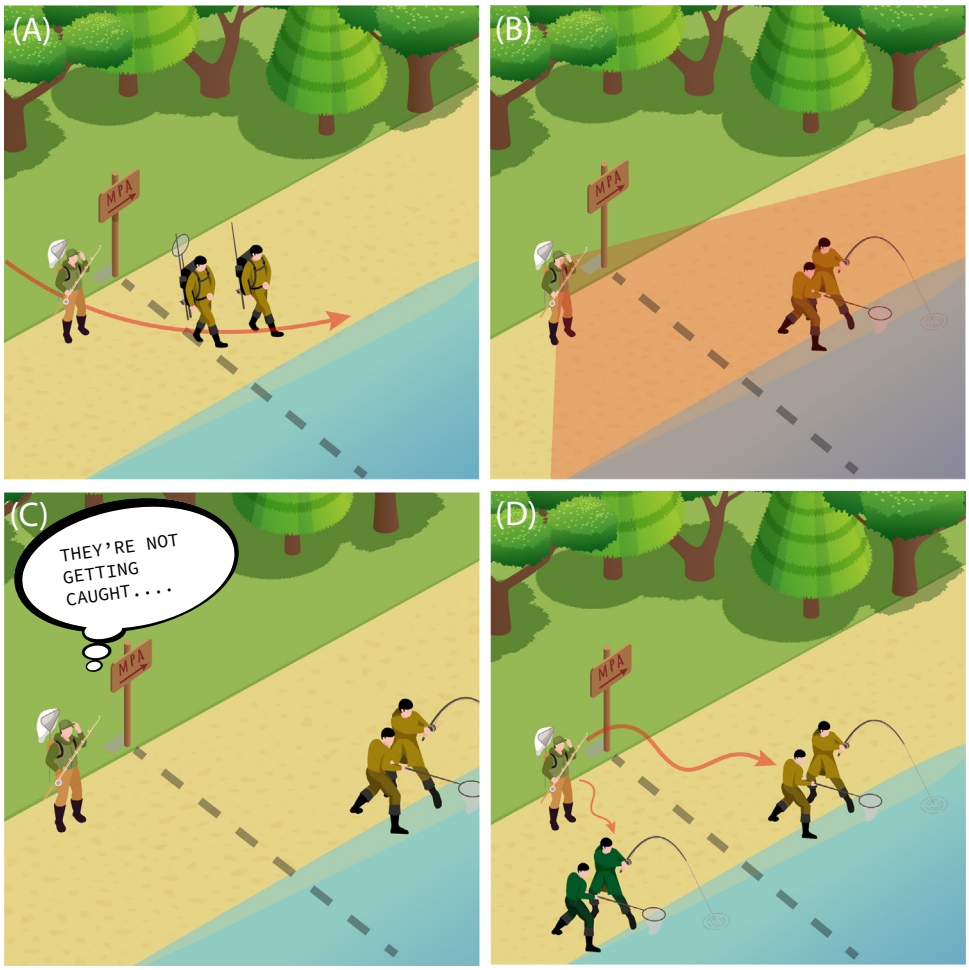

Figure 2. Possible cognitive mechanisms underlying rule non-compliance. Here, an individual fisher (A) has their imitation response triggered (motor processes) as two fishers move past them and a sign indicating a Marine Protected Area (MPA) where fishing is not allowed (fishing is prohibited in the area on the right-hand side of the broken line, and the curved red arrow indicates the movement of the two fishers moving inside the MPA to start fishing). (B) Their gaze is drawn to two fishers acting in non-compliance by harvesting inside the boundaries of the MPA (perceptual and attentional processes – the observing fisher's field of view is shown in the red shaded area). (C) The fisher evaluates a specific situation of non-compliance where their attitude towards engagement changes (evaluative process), and in (D) fishers are seen breaking a rule and the rule-breaking behaviour is more readily attributed to the rule breakers wider representative group (i.e., all local fishers) than when fishers are seen complying with the rule (asymmetrical learning rates) – shown here as red sinuous lines – the more a behaviour is readily attributed to all group members the thicker the line is. Figure created by W.N.S.A. using images from macrovector on Freepik.com.

redefine the situation (e.g., adequateness, and possible punishments), as well as redefine the role of another person or group observed to be non-complying (e.g., as a rule-breaker, or holder of useful information) and their own role in the situation. For example, from someone profiting from going fishing, to someone who is missing out [75]. This redefinition can be shaped by various factors. Among them, how many people are observed not complying (quora) might affect if the fisher keeps to their original motivation and self-identification, or whether the fisher adapts it [43,76]. But the fisher's interactions with the non-complier can play a further crucial role. If they interact with the person or people engaging in non-compliance (e.g., eye-contact, verbal engagement), the duration of interaction, the non-complier's emotion expressions and possible emotional

contagion, and the observing fisher falling into a shared rhythm with the non-complier, might lead to the fisher identifying with them and can make it more likely to follow them in an act of non-compliance [77,78]. If they, in their interaction, or short conversation, establish a joint out-group (e.g., the park rangers), the observing fisher might be more likely to define as part of an in-group with the observed rule-breakers and might be more likely to break the rule themselves [67,75]. However, people do not always directly view the act of non-compliance, positing additional challenges. People might incorrectly estimate the number (or fraction) of other people breaking the rule, and they might identify less (or more) with the group of rule-breakers that they have in mind (i.e., they might assume this group is more similar or different from them in terms of class, gender, age, or other relevant reference classes regarding norms and motivations).

While our focus is on the situational aspects (how they might be activated, or might change), the role of presituation versus situational factors (and their interplay) leading to behaviour, such as non-compliance, remains understudied. For instance, the rationale to break a rule might be a highly conscious decision primarily driven by localised political factors [17]. Understanding variation in these behavioural dynamics will likely require sampling presituational and situational drivers of non-compliance and investigating heterogeneity across contexts of interest. To properly understand the role that situational social influence processes play in emerging non-compliant behaviours, an integrated research agenda is necessary. A research agenda that links the key cognitive mechanisms underlying the decision-making process to break a rule (Figure 2), with detailed spatiotemporal data of people's collective dynamics and interactions, and their surrounding environment, directly prior, during, and immediately after, decision-making takes place.

Data and experiments

Methodological constraints in data acquisition have been a bottleneck in the study of collective dynamics and behaviours in humans until recently. Technological developments in mobile monitoring and other geolocated devices now allow researchers to gather detailed spatiotemporal data of human interactions to test the situational social influence processes leading to individual and collective non-compliance in natural systems [16,79,80]. Videos recorded for resource management (e.g., remote electronic monitoring on fishing vessels) [81,82] or that are uploaded by resource users (e.g., catch-and-release by anglers) [83] can help researchers study in-group interactions like density, gestures, speech, or expressions of emotion [79,84]. Remote observation technologies such as drones and camera traps can also be used to gather interaction data within and between groups in conservation contexts [12,85,86]. Although care is needed to ensure that research using these tools does not erode public safety, privacy, or wellbeing [87–89]. For experimental interventions, wearable geolocated devices and eye-tracking glasses can be used to assess people's interaction dynamics and to determine whether individuals pay more attention to compliant or non-compliant behaviours [16,90,91].

The use of virtual reality (VR) in human behaviour experiments shows promise as a tool to allow researchers to test certain cognitive mechanisms underpinning non-compliant behaviours, as well as testing interaction dynamics before non-compliance emerges, in a controlled and reproducible experimental setting [92,93]. These data can then contribute to the parametrisation of agent-based models of collective non-compliance [15]. However, further testing that VR experiments of rule-breaking predict rule-breaking behaviour in the physical world is required.

In the field, experimental intervention that uses appropriate controls to test how people respond is a particularly suitable approach (e.g., infringements of local regulations) [94]. For instance, experimentally testing how situational social influence processes might drive people's deviation from waymarked paths in terrestrial protected areas (Box 2). Paths of different visibility could be

constructed and their use monitored. Experimental designs could give participants a task to get to a destination through a protected area where leaving the waymarked path is forbidden. The experiment could be recorded, analysed, and compared with modelled predictions.

Concluding remarks

Non-compliance research could benefit from a deeper understanding of the fundamental principles that underpin non-compliance in individuals and in groups (see Outstanding questions). Quantitatively and experimentally testing situational social influence processes that can lead to non-compliant behaviours presents clear benefits. For example, linear spreading dynamics or quorum thresholds for behaviour change in groups can be quantified, which, in turn, can inform the empirical foundation of statistical models predicting socially influenced non-compliant behaviours. This understanding can support applied non-compliance research to improve the framing, development, and implementation of conservation interventions.

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Declaration of interests

No interests are declared.

Outstanding questions

- How does the likelihood that someone will break a conservation rule change as the number of people they see violate the rule increases?
  - How is the shape of the relationship of group size to conformity affected by identifying with the group, or (prolonged) personal interaction with them?
- Is situational social influence through copresent or trace contagion a stronger process?
  - For what type of non-compliant behaviours are situational social influence through copresent or trace contagion particularly prevalent? And how does environmental heterogeneity influence this relationship?
- How often do you have to be a follower in non-compliance to become a leader?
- Which cognitive and which interactional mechanisms have the most significant effect on non-compliant decision-making, and how does this vary across contexts of non-compliance?
- How do peoples' attitudes and beliefs towards biodiversity conservation influence their receptiveness to situational social influences on non-compliant decision-making?

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