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How to Live in Peace? Mapping the Science of Sustaining Peace: A Progress Report

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Despite good faith attempts by countless citizens, civil society, governments, and the international community, living in a sustainably peaceful community continues to be an elusive dream in much of our world. Among the challenges to sustaining peace is the fact that few scholars have studied enduringly peaceful societies, or have examined only narrow aspects of them, leaving our understanding of the necessary conditions, processes and policies fragmented, and deficient. This article provides a work-in-progress overview of a multidisciplinary, multimethod initiative, which aims to provide a holistic, evidence-based understanding of how peace can be sustained in societies. The Sustaining Peace Project, launched in 2014, uses complexity science as an integrative platform for synthesizing knowledge across disciplines, sectors and communities. This article introduces the multiple components of the project and shares preliminary findings.

Public Significance Statement


This article introduces the Sustaining Peace Project, a multimethod, multidisciplinary initiative, which aims to provide a holistic, evidence-based understanding of how peace can be sustained in societies. It summarizes the lessons learned to date from the systematic study of sustainably peaceful societies and “peace systems,” or clusters of peaceful societies, which combines methods from psychology, peace studies, and complexity science to offer both a parsimonious and comprehensive understanding of sustaining peace locally and globally.


Keywords: peace, sustainability, complex systems


Today, too many people around the world have come to accept violence, military engagement, and war as legitimate methods of problem solving. Many see this as the way things have always been—a belief based on views proffered by the likes of Thomas Hobbes in the 1600s and by many politicians today—that humans are inherently selfish, territorial, and warlike. However, the facts from human history tell a different

story. Ample evidence from archeology, anthropology, history, and political science, tells us that for the vast majority of our time on this planet (about 2 million years for genus *Homo*), we lived in peace (Fry, 2006, 2015). In fact, war and intergroup violence are relatively new inventions—first surfacing around 10,000 years ago (Haas, 1999). On the contrary, we have shown a strong proclivity for peace.

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Nevertheless, more countries have recently experienced violent conflict than at any time in the last 30 years (United Nations, 2018), and the numbers of refugees, internally displaced people and global military spending have been at historic highs (Internal Displacement Monitoring Centre, 2019; Tian et al., 2020). In 2018, the economic impact of violence on the global economy was over \$14 trillion (Institute for Economics & Peace, 2019). By 2018, the number of people fleeing war, persecution, and conflict exceeded 70.8 million. Today, over 2 billion people live in conflict-affected countries (USAID, 2020), which have a devastating impact on the mental health of affected populations (Catani, 2018).

It is in this context that the international community has been attempting to turn its attention toward sustaining peace. A 2015 United Nations report states, “If there is a principal *raison d’être* for the creation of the United Nations, it is to sustain international peace in all its dimensions” (United Nations, 2015, p. 11). However, since 1992 and United Nations Secretary General Boutros Boutros-Ghali’s *Agenda for Peace*, United Nations member states have struggled to reorient the work of the United Nations beyond crisis management and conflict mitigation to prioritize sustaining peace. The 2015 report, authored by an advisory group of experts selected by United Nations Secretary General Ban Ki Moon, found the United Nations to be failing in this area, claiming, “(It) is an overarching finding of this report that the key Charter task of sustaining peace remains critically under-recognized, under-prioritized and under-resourced globally and within the United Nations system” (United Nations, 2015, p. 11–12). In April 2016, the United Nations responded by adopting landmark reso-

lutions offering sustaining peace as the overarching framework for revitalizing the work of the United Nations. This was followed by yet another report by the Secretary General in 2018, which detailed many of the internal and external setbacks to the agenda (United Nations, 2018).

Science could play a vital role in guiding United Nations policy and programming on peace by specifying the basic conditions and processes that increase the likelihood of sustaining peace in societies. Unfortunately, our understanding of peaceful societies is limited by the fact that they are rarely studied by peace scholars. Peace scholarship tends to focus on the de-escalation or mitigation of aggression, violence and war—and on peacekeeping, peacemaking, and peacebuilding in the context of war—assuming that doing so will shed sufficient light on sustaining peace (Coleman, 2018a; Coleman & Deutsch, 2012; Fry, 2006; Gleditsch et al., 2014; Goertz et al., 2016; Mahmoud & Makoond, 2017; Vallacher et al., 2013). A study reviewing articles from the *Journal of Peace Research* and the *Journal of Conflict Resolution*, top journals in the field, empirically found that the main focus of peace research has always been negative peace, or reducing war (Gleditsch et al., 2014). When peacefulness is studied it tends to be viewed through narrow disciplinary or sectorial lenses that often essentialize its antecedents and oversimplify the complex, idiosyncratic dynamics of more peaceful communities (Brusset et al., 2016; Coleman, 2012a, 2018b; Day, 2018; De Coning, 2018; Körppen et al., 2008; Ricigliano, 2012). Although it is clear that the variety of different aspects of sustainable peace cannot be easily synthesized in any single model (Harris & Morrison, 2012), the absence of a more comprehensive understanding impairs the articulation of effective policies, programs, and measures for sustaining peace (Goertz et al., 2016).

In response to these challenges to comprehending and promoting more sustainably peaceful societies, the *Sustaining Peace Project* (SPP) was launched in 2014 at The Earth Institute at Columbia University as a multidisciplinary initiative focused on providing a holistic, evidence-based understanding of how peace can be sustained in societies. The project, supported by the university, uses models and methods from complexity science to conceptualize and measure *the complex temporal dynamics of more sustainably peaceful societies*. Complexity science is a branch of applied mathematics that studies the emergence, evolution, and decline of complex systems of all kinds—from cancer cells to communities to constellations of galaxies—that has been used increasingly in psychology (Svyantek & Brown, 2000; Vallacher & Nowak, 2007; Vallacher et al., 2002), and is often used as an integrative platform for working across disciplines (Bar-Yam, 2002). The SPP team is composed of experts from disparate disciplines, including a social psychologist with expertise in peace and conflict studies, a political-environmental scientist with an expertise in



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community-participatory methods, an anthropologist with expertise in the study of peaceful societies, an expert in physics, mathematics, and computer science, a systems analyst with a background in bio-engineering and philosophy, a specialist in organizational psychology and global thought, and a philosopher with a background in international relations and human rights. The project has also benefitted from the contributions of members of various international organizations, including the United Nations, The World Bank, and the International Peace Institute, in addition to a variety of other national and international colleagues and students across academia and the public sector. This article provides an overview of the project to date, detailing its rationale and six main components, and shares several preliminary findings. A list of all abbreviations used can be found in Table 1.

The SPP: Its Origins and Structure

The SPP was inspired by a central finding from the ethnographic study of peaceful societies, which suggests that they are much more likely to evolve in peaceful direc-

tions if they define themselves as peaceful and have a clearly specified sense of what it entails (Bonta, 1996, 1997; Dobinson, 2004; Fry, 2006, 2015; Howell, 1989; Ireland, 1988; Schlegel, 2004). In other words, more sustainably peaceful societies of various sizes and degrees of complexity such as the aboriginal communities of the central Malaysian Peninsula (Batek, Chewong, Semai, etc.), the Inuit peoples of the Arctic, and nation states such as Costa Rica, Finland, New Zealand, and Mauritius, tend to develop identities, mindsets, language, values, habits, norms, rituals, taboos, and institutions necessary to sustain peace. This project aims to synthesize what empirical science across many disciplines has to offer toward specifying such visions as complex, dynamic systems.

Work on the SPP is modeled on the *Foresight* process (see Vandenbroeck et al., 2007), a method developed in Great Britain which uses complex system visualizations and future scenario planning as a platform to bring scientists, practitioners, community stakeholders and policymakers together in service of better comprehending and addressing complex societal challenges. The general objectives of the SPP are to (a) *increase awareness of the hundreds of peaceful societies around the world today*; (b) *increase understanding of how communities sustain peace* by using empirical science, complexity visualization, mathematical modeling, and stakeholder dialogue together in mutually informative ways; (c) *support more adaptive decision-making processes* by developing interactive decision-support tools for leaders; and (d) *have a positive impact on communities globally* by supporting decision makers in doing less harm and enhancing wellbeing by improving their understanding of sustaining peace and of intervening in complex systems.

The project has six main components: (1) development of a *basic theoretical model* of the core dynamics of sustainably peaceful societies, (2) generation of a *causal loop diagram* (CLD) or visualization of how many empirically derived peace-related factors interact to affect the core dynamics, (3) *validation of propositions* derived from the model against extant research and comparative data from peaceful and nonpeaceful societies, (4) development and testing of a *mathematical model and computer simulation* of the CLD of sustaining peace, (5) “*ground truthing*” the

Table 1
Abbreviations Used

Abbreviation	Explanation
CLD	Causal loop diagram
Core engine	Refers to: Positive and negative intergroup past historical accounts, current norms and structures, and future goals and expectations
NIR	Negative Intergroup Reciprocity
PIR	Positive Intergroup Reciprocity
SPP	Sustaining Peace Project



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model by interrogating it through dialogue with community stakeholders and policymakers working locally on sustaining peace and, (6) development of new *methods and metrics* for measuring and tracking trends related to sustaining peace.

Ultimately the project aims to offer a set of findings, visualizations, simulations, and other interactive tools through a public website (<https://sustainingpeaceproject.com/>; Sustaining Peace Project, 2020) that provides academics, policymakers, and community stakeholders with a better understanding of the dynamics of sustainably peaceful societies, the role their own activities can play in bolstering such communities, and how to mitigate the unintended negative consequences of policies and projects aimed at building peace. In other words, it aims to use complexity science as an integrative platform to synthesize knowledge across disciplines, sectors and communities in service of building and sustaining world peace.

Below, the procedures and preliminary findings from the six project components are outlined in brief (for more complete descriptions, see Coleman et al., 2019, 2020; Liebovitch et al., 2019; Mazzaro et al., 2015).

Model Development: Exploring the Nature of Sustainable Peace

As there is little consensus on how to conceptualize *peace* (Coleman, 2012a; Goertz et al., 2016), the initial phase of the project involved a comprehensive search of the published literature on peace across disciplines to identify metaphors, definitions, factors, and indices relevant to sustaining peace. It built on the foundational work of others

(Boulding, 1978; Christie et al., 2008; Coleman & Deutsch, 2012; Curle, 1971; Deutsch, 1973; Galtung, 1996; Lederach, 1998; Reardon, 2012), in particular anthropological research and case studies on peaceful societies (Bonta, 1996, 1997; Fry, 2006, 2012, 2013, 2015). The databases EBSCO, Web of Science Social Science Citation Index, and Google Scholar were searched and summarized to update the team on the extant empirical research on sustaining peace, and to identify other leading peace researchers.

From this search, 225 high-impact contemporary peace researchers were identified and invited to participate in a survey on the meaning(s), drivers and inhibitors of sustainable peace. The survey was designed to identify dominant metaphors and definitions of sustainable peace, and to locate antecedent peace factors from empirical research. Seventy-four experts from 35 disciplines responded to the survey (see Mazzaro et al., 2015). Responses were coded, categorized and analyzed by the SPP team of researchers. Although no consensus on the definition of peace was reached at this stage, the analysis resulted in a convergence of the categories of elements identified as associated with sustaining peace. Of the 601 elements specified, 62% referred to factors that fell within six categories: *quality of social relations, cooperation, interdependence, access to resources, equality, and human security*. These components were subsequently integrated into the initial draft of the conceptual model (Mazzaro et al., 2015).

In October 2015, a draft model of the core dynamics of sustaining peace was presented and discussed at a full-day workshop, where experts who participated in the survey along with other members from policymaking and peacebuilding reviewed the findings. Fifty participants gathered and discussed the draft model, offering recommendations for revision and enhancement. The feedback on the model included a need to better specify its underlying values, assumptions and definition of terms, as well as a narrowing of its scope. Subsequently, the project team revised the model, working through several iterations based on their areas of expertise, understanding of the literatures, survey findings, and workshop input (see Mazzaro et al., 2015).

The resulting conceptual model of sustainably peaceful societies has the following boundaries and assumptions:

- It assumes sustainably peaceful societies are possible, as evidenced by data collected from past and present societies around the world (see Fry, 2006, 2012, 2015). Although how to measure peacefulness is a highly contested matter (see Coleman, 2012a), sustainably peaceful societies are operationalized for this project as those that have been internally and/or externally nonviolent and predominantly pacific for a period of 50 years or more (approximately two generations), as there is evidence to suggest such societies are significantly less



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likely to relapse into patterns of violence (Goertz et al., 2016).

- It focuses at *the level of intergroup dynamics within and between communities*. This reflects a decision to focus the model at a level where societal peace and conflict dynamics often become structurally and normatively organized. It also assumes that the core dynamics at the intergroup level can be scaled up to represent communities from small villages to nations to the international community, with some modification—a common assumption in multilevel research on conflict (Rubin & Levinger, 1995), and more generally (Kozlowski & Klein, 2000).
- Its primary focus is on *representing current dynamics of sustaining peacefulness* within and between communities (as opposed to transitions to or from peacefulness; see Goertz et al., 2016 for a study on these transitions).
- It focuses principally on the *flow of facilitating and inhibiting dynamics between variables*, and on how these dynamics affect the sustainability of higher-level or emergent patterns of societal peace. In other words, rather than emphasizing particular factors or conditions conducive to peace, the model focuses on how these various factors combine to influence each other over time, resulting in more and less stable patterns of peacefulness at the societal level.
- Building on Boulding (1978), the model defines sustainable peace as *a state where the probability of using destructive conflict and violence to solve problems is so low that it does not enter into any group's strategy, while the probability of using non-*

violence, cooperation and dialogue to solve problems, promote social justice and increase well-being is so high that it governs social organization and life.

- The model also assumes that negative states (destructive conflict, violence, and war), and positive states (more just, inclusive, harmonious, and prosocial) are related but qualitatively different phenomena—each with its own set of predictors, processes, and outcomes (Coleman, 2012b; Galtung, 1969; Goertz et al., 2016). This suggests that the antecedents and conditions associated with stable states of destructive, enduring conflict are not the opposite of, but rather are mostly distinct from those identified with enduring forms of peacefulness.
- Accordingly, two attractors for intergroup dynamics, which represent these two sets of distinct probabilities, constitute the conceptual model of sustainable peace (see Coleman et al., 2020). Attractors, a term from applied mathematics, are defined as *a state or pattern of changes toward which a complex system evolves over time and to which it returns if perturbed* (Vallacher et al., 2010). In other words, although dynamic and constantly changing, they are relatively stable states. Attractors are determined by the interactions between a variety of different variables at different levels of analysis, culminating in patterns in systems (e.g., groups, communities, or nations) that *attract the dynamics of the system and resist change*. Thus, attractors can represent patterns that are more robust and sustainable.

The resulting conceptual model of sustaining peace provided a basic framework for building a CLD of the system of factors that research has identified as influencing the probabilities of sustaining peace.

The CLD: Visualizing the Complex Dynamics of Peace

The focus of the conceptual model of sustaining peace on attractors highlights the importance of their *system dynamics*, which can be visualized as reinforcing and inhibiting feedback loops that connect their many factors (Vallacher et al., 2013). *Reinforcing loops* occur where two or more factors influence one another mutually along the same or similar trajectory as originally inclined (an increase in A leads to an increase in B, which in turn further increases A), whereas *inhibiting loops* occur where two or more factors obstruct or constrain each other's initial flow (an increase in A leads to a decrease in B, which in turn decreases A). Certain configurations of these loops result in *self-organizing system dynamics*, which resist outside influence and so create change-resistant patterns. These are a particular type of attractor. Accordingly, an assumption of the



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CLD is that sustaining peace can be fruitfully conceptualized as *a set of complex feedback dynamics between many factors at multiple levels, which result in the emergence of strong attractors for constructive interactions between groups and weak attractors for destructive interactions.*

Following the *Foresight* approach (see Vandebroek et al., 2007), the steps to conceptualizing and diagramming highly complex and dynamic societal phenomenon include: (a) specifying the *nodal focus* of the model, or the anchoring point around which the system's map is meant to revolve; (b) identifying the *core dynamics* of the model, or a limited set of factors and feedback loops that capture the essential dynamics of the phenomenon; and (c) building out the *broader factors* of the model, or the variables found to influence the nodal variable more indirectly through the core engine.

The Nodal Focus: Defining the Essence of Sustaining Peace

Often, dynamical models of complex, emergent phenomena have simple, even mundane nuclei (Nowak, 2004). Given the model's emphasis on constructive and destructive intergroup dynamics, the nodal focus selected was on the fundamental social dynamic of intergroup reciprocity (Kropotkin, 1902), a process seen as central to both positive (Dovidio & Banfield, 2015; Fry, 2015) and negative (Eisenberger Lynch et al., 2004; Kteily Hodson, & Bruneau, 2016) intergroup relations. *Reciprocity* can be defined as a social rule that says people should repay, in kind, what another person has done or given them, whether of a positive or negative nature (Cialdini, 2006). In behavioral terms it

describes the tit-for-tat or mirroring interaction dynamic between two entities (see Segal & Sobel, 2007).

Fry (2015) views *positive reciprocity* as a central component of peaceful societies. He writes:

In my view, peace is not just an absence of war, but also people getting along prosocially with each other: the cooperation, sharing and kindness that we see in every day society. Peace is positive reciprocity: I show you a kindness and you do me a favor in return, multiplied throughout the social world a million times over. (Fry, 2013, p. 544)

Positive Intergroup Reciprocity (PIR) occurs when an action committed by a member of one group (A) that has a positive effect on a member of another group (B) is returned to a member of the original group (A) with an action that has an approximately equal or more positive effect (Caliendo et al., 2012). *Negative Intergroup Reciprocity* (NIR) occurs when an action by a member of one group (A) that has a negative effect on a member of another group (B) is returned by a member of B with an action that has an approximately equal or more negative effect on a member of A (Caliendo et al., 2012). PIR and NIR then are not merely conditions or actions, but are *interactive dynamics* between members of different groups.

However, the effects of positive and negative reciprocity are not symmetrical, with research finding that, even when of equal intensity, elements of a more negative nature (thoughts, emotions, actions, and events) have a greater and more lasting effect on one's psychological state and social processes than do neutral or positive elements (Baumeister et al., 2001; Kanouse & Hanson, 1971). Accordingly, more sustainably constructive relationship dynamics tend to evidence higher ratios of positivity to negativity of somewhere between 3:1 to 5:1 (see Fredrickson, 2013; Gottman et al., 2014, 2002; Kugler & Coleman, 2020; Liebovitch et al., 2011).

Thus, the *nodal focus* of the CLD of sustaining peace in societies is operationalized as *the ratio of PIR to NIR*. In other words, the model proposes that the central dynamic responsible for the emergence and maintenance of sustainably peaceful relations in societies is the thousands or millions of reciprocal intergroup interactions that occur between members of different groups in those communities daily, and the degree to which more positive interactions outweigh the more negative: the higher the ratio of PIR:NIR, the higher the probability of sustaining peace (Figure 1).

The Core Dynamics: Identifying the Primary Drivers Sustaining Peace

Building out from the nodal focus of the model, the *core dynamics* represent a limited set of factors and



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feedback loops that capture the essential dynamics most directly affecting the ratio of PIR to NIR in communities. The CLD for sustainable peace proposes three categories of core dynamics that most affect the nodal focus, which represent group experiences and expectations of the past, present, and future: (a) *Past Intergroup Historical Accounts* (positive or negative stories, symbols, memories, ceremonies, documents, etc.) of past events that promote, prevent, or mitigate PIR and NIR, which, in turn, affect the salience, strength and accessibility of these same histories; (b) *Current Intergroup Norms and Structures* (cooperative or competitive standards, institutions, incentives, and processes) operating in the present context to

promote, prevent, or mitigate PIR and NIR, which, in turn, affect the strength of these same norms and structures; and (c) *Future Intergroup Goals and Expectations* (positive or negative goals, objectives, plans, visions, agreements, etc.) around future intergroup encounters that promote, prevent, or mitigate PIR and NIR, which, in turn, affect the strength of the influence of these same expectations (see Figure 2; see Coleman et al., 2020).

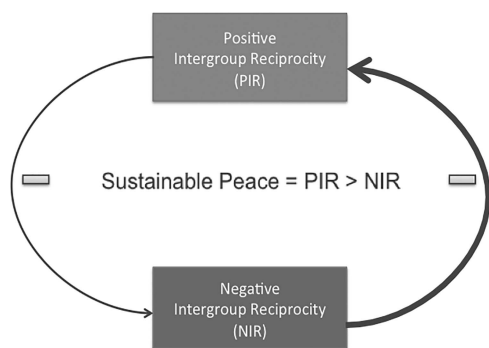
To summarize, the three primary dynamics of the core engine (past historical accounts, current norms and structures, and future goals and expectations) of the model mutually influence and are influenced by PIR and NIR. These three sets of dynamics all serve to increase or decrease the likelihood of PIR and NIR, affecting their incidence, the strength of their associated positive and negative attractor dynamics, and the concomitant probabilities for sustaining peace. Together, the nodal focus and core engine of the model present the most central dynamics affecting the emergence, strength, and sustainability of constructive and destructive intergroup attractor dynamics within and between communities and, therefore, the probabilities of sustaining peace (see Figure 2).

The Extended CLD Visualization: Building the Model Out Into Societies

The initial expert survey, workshop, and literature reviews helped to identify a number of other important variables and dynamics found to be empirically related to sustainable peace between groups. To date, we have identified 73 total variables that have been mapped onto the CLD for a more fully determined model (see below). These variables begin to account for the many contributions to sustaining peace operating at individual, community, and macro levels of society. Because of the demonstrated orthogonality of violence-preventing and peace-promoting factors (Goertz et al., 2016), they have been separated in the CLD into those *primarily* preventing or mitigating destructive intergroup interactions (NIR—at the bottom of the full map) and those promoting more constructive relations (PIR—at the top). In March 2018, the project team reviewed each of the variables and relationships between them as informed by empirical research, and participated in a complexity mapping session to build the CLD visualization out further. This resulted in a more robust and comprehensive CLD, but one of considerably more complexity (Figure 3).

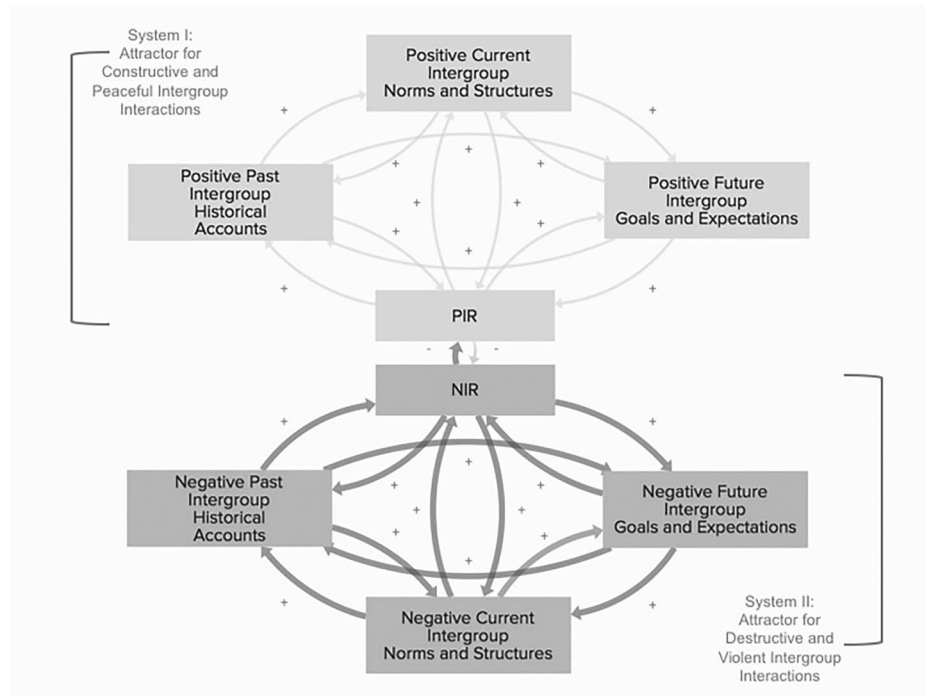
It is important to emphasize here that complex systems (groups, communities, nations, and so on) are thought to be *equifinal*, meaning that there are usually a variety of different pathways to the same outcomes (i.e., peace). This suggests that different combinations of the various violence-mitigating and peace-promoting factors can operate in different communities

Figure 1
The Nodal Focus of the CLD of Sustaining Peace



Note. CLD = causal loop diagram; PIR = Positive Intergroup Reciprocity; NIR = Negative Intergroup Reciprocity.

Figure 2
The Core Engine of the CLD of Sustainable Peace



Note. CLD = causal loop diagram; PIR = Positive Intergroup Reciprocity; NIR = Negative Intergroup Reciprocity.

to drive and sustain peace, as long as the PIR dynamics sufficiently outweigh the NIR dynamics.

Validation of the Model: Identifying and Generating Empirical Support

The next phase in the process of model building was to begin to validate the many propositions arising from the full model of sustainably peaceful societies (see Coleman et al., 2020). For example, the CLD of the core engine alone yielded a series of 26 propositions on the relations between the eight variables in the core model (see Figure 2; Coleman et al., 2020). Given that the CLD uses feedback loops to capture the mutual, dynamic flow of influence between variables, but that the vast majority of published research relevant to sustaining peace is of a unidirectional nature (causal or correlational), each feedback loop was represented by two propositions, resulting in 186 initial propositions. These propositions are currently being validated through several means: identification of existing published studies supporting each, recoding of ethnographic data comparing peaceful and nonpeaceful societies, and use of data science methods.

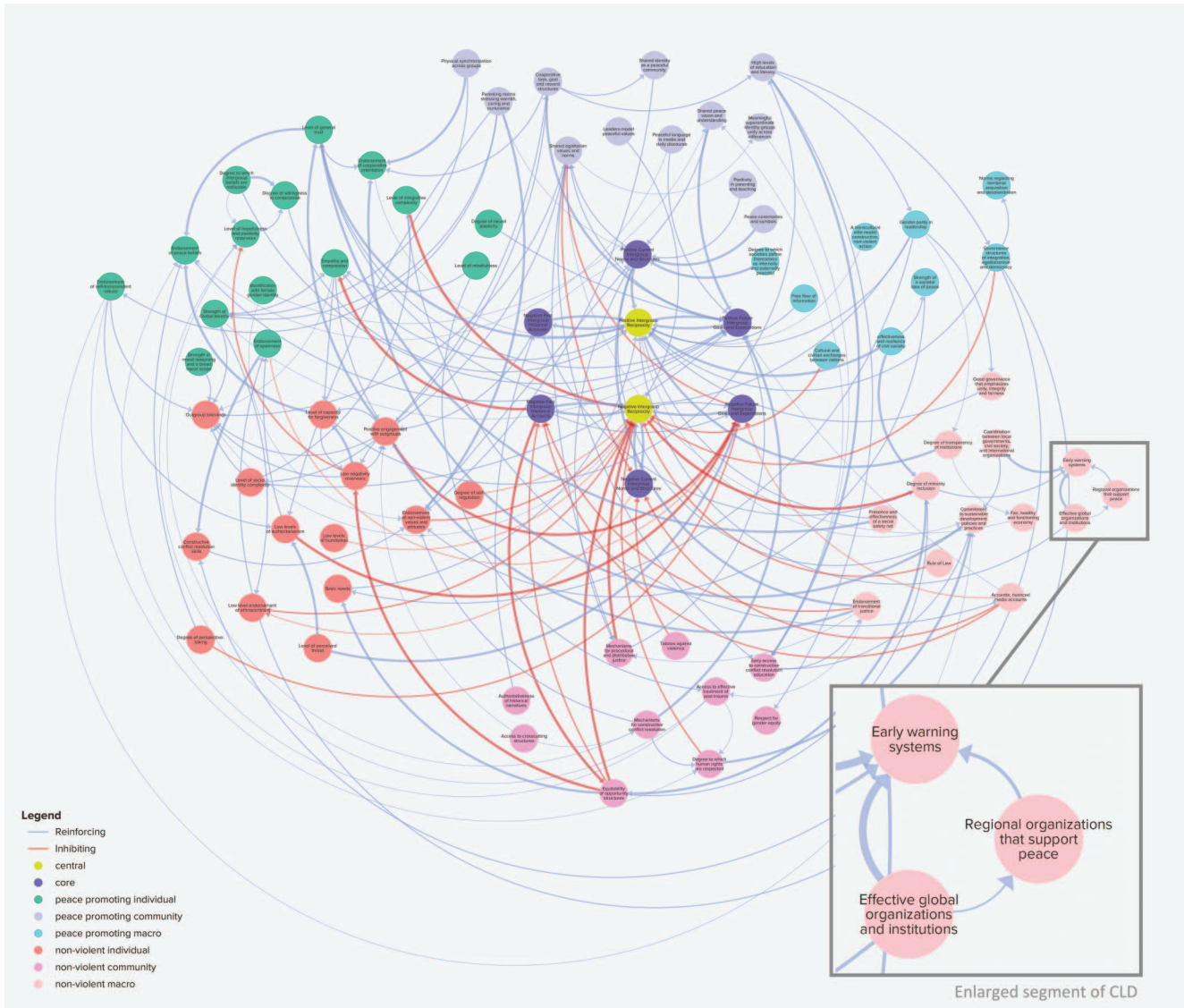
Identification of Empirical Support and Effect Sizes

Subsequent to the specification of the core engine and resulting propositions, the team conducted a second re-

view of the relevant empirical research. To validate the initial propositions, the team searched for each of the eight variables as key terms (as well as variant operationalizations of the variables), privileging empirical studies from peer-reviewed journals. Both qualitative and quantitative empirical studies were reviewed and summarized for each proposition. To date, over 300 empirical studies have been identified supporting the relationships between the variables. Many of these studies come from social and political psychology literatures focusing on cross-cultural, interethnic, and intergroup relationships, and the studies provide robust support for the connections between the variables of the core engine.

Findings from *quantitative* studies related to connections within the core engine were further analyzed and synthesized, drawing on methods from random effects meta-analysis, to determine overall effect sizes in the form of a summary correlation coefficient that speaks to the strength of the connections between each set of variables (Hedges & Olkin, 1985; Schmidt & Hunter, 2014). Drawing on the proposed thresholds suggested by Cohen (1988), it was determined that summary correlations of less than 0.2 would be considered *low* in strength; those between 0.2 and 0.4 *medium* in strength; and over 0.4 would be considered *high* in strength. This process also helped to identify where there is strong

Figure 3
The Full CLD of Sustaining Peace



Note. CLD = causal loop diagram. For more information see <http://sustainingpeaceproject.com/peace-tech/visualizing-sustainable-peace>. See the online article for the color version of this figure.

support for the relationships between the variables in the model as well as areas needing future research.

Investigation of Peace Systems Versus Nonpeace Systems

Another approach to validation of the SP model involves the examination of peace systems. Peace systems are “groups of neighboring societies that do not make war on each other” (i.e., a form of *negative peace*; Fry, 2012, p. 879). The member societies of a peace system may or may not engage in war outside the boundaries of the peace system; some peace systems, therefore, are com-

pletely nonwarring whereas others are not. Examples include the Iroquois Confederacy, the tribes of the Upper Xingu River Basin in Brazil, the Indian societies of the Wynaad Plateau, the Swiss Cantons, and the European Union. Summary descriptions of peace systems from diverse parts of the world can be found in Fry (2009, 2012, 2013) and Fry et al. (2008); see also Kupchan (2010). The key question in peace system research relevant to our current project is: What are the main features of sustainable peace operating within peace systems?

For peace systems, approximately 15 examples were investigated ranging from the Nordic countries, Swiss

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cantons, the Montagnais-Naskapi-East Main Cree groups of the Canada, the societies of Peninsular Mainland Malaysia, the peoples of India's Nilgiri Hills, the Australian Aborigines of the Great Western Desert, city-state Italy, the Iroquois confederation, and so on. A comparison group of approximately 30 societies was selected by use of a random number generator from the Standard Cross-Cultural Sample, a collection of ethnographic and historical information on nearly 200 societies selected to represent the cultural provinces of world societies.

A coding protocol is being used to assess how peace system societies compare with nonpeace system societies. Variables of interest pertain to how peace is sustained, or not, and include assessments of many variables affecting the core dynamics of the SP model, including the degree of an overarching social identity among neighboring societies, interconnections such as trade or intermarriage, the degree to which neighbors are interdependent upon one another in terms of ecology, economics, or security concerns, the degree to which norms and core values support peace or war among neighbors, the role that rituals, symbols, and ceremonies may play either to link or to divide neighboring societies, the degree to which superordinate institutions exist that span neighboring societies, whether intergroup mechanisms for conflict management and resolution exist, and the presence of political leadership for war or peace. The final analysis of this research is nearly complete and promises to yield important insights about the maintenance of sustainable peace. Preliminary findings suggest strong support for many of the variables central to the current model.

Mathematical Modeling and Computer Simulation: Examining System Properties of the Model

The development of the CLD helped to identify some of the more important peace factors and how they interact with each other. In this way it provides an overall picture of the whole system. However, the CLD is limited in that it is hard to trace through the effects of a change in one peace factor to the many other factors that it influences and then even further from those influenced factors to the additional peace factors that they influence. In addition, the peace factors in the CLD do not have quantitative values assigned to them so their relative importance in the whole system is hard to determine.

Fortunately, the physical science expertise on the SPP team provided an additional approach that yielded new information on the system properties of the CLD. In physical science, mathematical models can be used to determine how microscale individual interactions between parts of a system produce the macroscale system properties of the entire system (i.e., the emergence of peace). A rigorous

mathematical model was constructed from the CLD (Liebovitch et al., 2018, 2019, 2020), where each peace factor has a quantitative value determined by its own properties and by its interactions with all the other peace factors. Thus, the interactions of all the peace factors can be computed together at once.

By running the mathematical model of sustainable peace, it was found that, over long periods of time, this system reaches only two stable configurations called "attractors": either the positive peace factors (such as Positive Intergroup Reciprocity or Positive Intergroup Goals and Expectations) have high values and the destructive conflict factors (such as Negative Intergroup Reciprocity or Negative Intergroup Goals Expectations) are low, or vice versa. In addition, a series of runs of the mathematical model have taught us that the stronger and longer lasting effects of the destructive factors can be restrained either by including the influence of many additional positive peace factors in the system, or by strengthening "gateway" positive factors that play crucial roles in how interactions spread through the whole system. Because there are different ways to achieve a successful peace system this also implies that the best choice of an intervention may often be situationally dependent.

The mathematical model is only useful to scientists, practitioners, and policymakers if they understand its behavior and are able to vary the parameters of the model to explore consequences of those interventions. Therefore, the SPP team created a graphical user interface (GUI) for the mathematical model derived from the CLD. This computer program (coded in Python 3 using Tkinter) is available, as open source, on GitHub (Liebovitch, 2018). The program presents the names of the peace factors on the screen with sizes proportional to their values.

The SPP team subsequently formulated operational definitions of the peace factors and have been using data science methods to analyze structured and unstructured (social media) data to provide quantitative values of the eight variables of the core engine, toward developing enough quantitative empirical data to further test, improve, and validate the model (see Liebovitch et al., 2019; Telang et al., 2019). The development of a validated, user-friendly model will provide scholars and practitioners a helpful tool for understanding sustainably peaceful systems and designing effective interventions.

Ground Truthing of the Model: Refining Theory Through Lived Experience

Increasingly, research is finding that top-down one-size-fits-all approaches to policymaking in peace and development are often ineffective and unsustainable (Wessells, 2015), particularly because they exclude the insight and expertise of local actors. However, local initiatives are not without their drawbacks (Boege, 2006), and may benefit

from the lessons and insights from the science of peace. In response, the SPP team has been developing a *community-science dialogue process* that uses questions derived from research on sustaining peace to facilitate community discussions on issues of interest and concern to communities. As part of the process, stakeholders are asked to reflect on a series of questions related to sustainable peace, such as: What would sustainable peace mean here and what are the main elements that you believe would be vital for peace to be sustained? This process is called *ground-truthing* (Carp, 2008; Pickles, 1995).

Ground-truthing is an approach to data collection and analysis that attempts to validate aggregated information such as the outputs of a computer model, census and survey data, or population-level statistical information through more precise and often localized scales (Chambers, 2017; English, 2020). As applied in our work, ground-truthing is a structured process of dialogue facilitation that (a) relies on direct observation and engagement with community stakeholders to verify, refine, or challenge models derived by inference; and (b) uses scientific findings to structure community discourse on issues of interest or concern to communities. The purpose is to validate and refine academic understanding and assumptions against stakeholders' lived experiences in their communities about peace and intergroup relationships, and then to incorporate the insights gleaned from this process into the project's model of sustainable peace—but to do so in a manner that has utility for the communities.

After piloting the ground-truthing methodology in the Basque country in Spain (see Donahue et al., 2017), members of our team visited Mauritius for 10 days in December of 2019, and with our local partner, Professor Naseem Aumeerally, and her colleagues at the University of Mauritius, conducted ground-truthing through interviews and focus groups and visits to local sites relevant to its history of peace. Mauritius was chosen because of its high rankings on various international peace indices, and because of the high level of its ethnic and religious diversity. These sessions were focused on addressing the question, "What does it take to live in peace?", and included over 100 stakeholders from the public, private, academic, and civil society sectors.

For the focus group sessions, stakeholders were asked to come prepared to share a story that represents sustainable peace in their community. Stakeholders shared their stories and the project team and workshop participants listened actively to identify and record the processes, factors and conditions identified by each storyteller. These elements were recorded and then plotted on flipcharts, which were collected at the workshop's conclusion. A case study and report of the findings from this first case are currently in process (see Aumeerally et al., 2020). Subsequent ground-truthing workshops are currently being planned in Costa Rica, Norway, and New Zealand.

How to Track Peacefulness: New Methods and Metrics for Sustaining Peace

Most existing peace indices track the presence or absence of conflict, violence, and injustice, but to promote peace we *also* need to measure those factors that foster harmony and sustain peace (Coleman, 2018a; Goertz et al., 2016). The way peace is measured—through top-down, bottom-up or hybrid methods—also has important implications for research, funding, policy, and sustainability (Firchow, 2018). It is imperative that we develop methods and metrics that offer a more nuanced, comprehensive, and accurate representation of the components of sustaining peace.

Creating reliable measures of peacefulness is challenging, especially because the markers of peace are often less obvious than those of conflict and violence, and often manifest differently in diverse societies. Current widely used indices such as the *Global Peace Index* and the *Positive Peace Index* tend to focus on top-down analyst-driven indicators that often fail to account for local, context-specific meaning. In these indices, economic measures often have a great deal of weight, and other critical aspects of peace can be overlooked. Additionally, current metrics often assess linear and static relationship between factors, ignoring the complex, dynamic ways a constellation of elements influence how peace emerges.

To confront these challenges, we are currently developing a new set of methods and metrics for measuring peace. They combine both top-down generalizable (and comparable) methods and items, as well as bottom-up methods for localizing and customizing indices. Our process currently uses large-N statistical methods by using existing peace data to validate the theoretical model from the causal loop diagram. We will synthesize results from this statistical work (Fisher et al., 2020) and results from ground-truthing initiatives to develop indicators of peace and new data collection protocols that can be adapted to local contexts. Ultimately, this component of the project aims to develop a multidimensional index of peace to enable cross-case comparison and track peace trajectories longitudinally while simultaneously maintaining idiosyncratic nuance and context-dependent expressions of peace for any given case. While similar approaches are increasingly used in development studies (Alkire & Santos, 2010, 2014), no such method exists yet in peace and conflict studies. Key questions we are addressing include:

- How do we move beyond measuring peace as the absence of conflict, and start assessing peace as a positive state?
- What sorts of measures of peace are granular enough to be meaningful in specific local contexts, but generic enough to have value for a wide variety of people around the world?

- How can peace measures capture dynamic rather than linear relationships?

This work is in an early phase, but working with our local partners in various peaceful societies, we are hopeful of offering a means to track sustainable peace—both locally and globally, in the near future.

Preliminary Learnings and Conclusion

What have we learned to date about what it takes to live in peace?

First, we are learning that there are today and likely always have been many human groups and societies around the globe that choose peace over war. These societies represent an extraordinary untapped resource for mapping paths to peace. Think of this as a human genome project for societal peacefulness.

Second, we are learning that although sustainable peacefulness takes many forms and is highly complex and idiosyncratic, it can be understood, studied and modeled in very basic terms: as a high ratio of positive intergroup reciprocity to negative intergroup reciprocity that is stable over time. This simple core dynamic of peacefulness is allowing us to begin to connect the dots between the multitude of variables investigated in thousands of studies across dozens of disciplines relevant to sustaining peace. This more parsimonious *and* comprehensive approach to understanding peacefulness offers scholars and policymakers a birds-eye view of its complex dynamics, as well as insight into how particular policies and programs may result in unintended and even harmful consequences (Dorner, 1996).

Third, an extensive literature search as well as our preliminary coding of peace systems versus nonpeace systems suggest that the basic dynamics stipulated in the core engine of the model are valid—even though most of these findings are of a unilateral and not bilateral or dynamic nature. This is one limitation of the existing science that our mathematical modeling has been able to begin to supplement and address.

Fourth, through mathematical modeling we have been able to validate a basic assumption of our approach that highly complex forms of societal peace evidence attractor dynamics. Specifically, running the model over long periods of time found that these systems reach only two stable attractors: one for sustainable peace where the constructive peace factors have high values and the destructive conflict factors are low, or the opposite. We have also learned that the stronger and longer lasting effects of the destructive conflict factors can be mitigated either by including the influence of many additional positive peace factors, or by strengthening “gateway” positive factors that play crucial roles in how interactions spread through the whole system.

Fifth, by beginning to work with local partners and other stakeholders in sustainably peaceful nations, we are gaining

new insights into the critical importance of local understanding and interpretation of some of the key variables. For example, religiosity and religious differences can be a source of great divisiveness in many communities (see Moix, 2014). However, in Mauritius, a highly religious nation with large populations of Hindus, Christians, and Muslims, religiosity is tempered by tolerance and taboos around proselytizing, as well as a general belief in the value of spirituality, no matter the denomination. Such contextualization of variables highlights the limitations of the current inclination to use top-down, one-size-fits-all indices to track and rank national peacefulness, and the dire need for more flexible, locally informed methods.

Finally, we recently launched <http://sustainingpeaceproject.com/> that provides an overview of the project and the team, a map locating contemporary societies sustaining peace, an interactive version of the causal loop diagram that allows users to click on the variables and links between them to access the comprehensive evidence-base supporting the CLD, and an interactive version of the mathematical model that encourages users to plug in values and play with the model, to test their assumptions about affecting change in their communities, or to simply experience the curious forms of change evident when intervening in nonlinear systems. Through this resource, we hope to both share our preliminary learnings and tools, and to learn from others who choose to reach out and engage with us on this initiative.

The SPP is an ambitious undertaking, which requires much care and feeding. But there are few areas of inquiry in science that are more deserving. The nature of the transdisciplinary work that is required of such initiatives is demanding, and unfortunately few academic disciplines prepare their students for this type of work. Nevertheless, problem solving of complex global challenges requires this and is moving in this direction. Therefore, our work continues.

Of course, it would be foolish to claim that all peaceful societies are the same—their differences are clearly manifold. However, perhaps at its core, sustaining peace can be understood and modeled as a set of fundamental underlying human dynamics, that are in turn affected by the thousands or millions of conditions and processes that are most evident in these differences. This is the ultimate aim of the SPP—to use the best of science to learn from and celebrate the multitude of peaceful people and places that shine so bright in our world.

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