



TECHNICAL DOCUMENT 3354
September 2018

Patterns of Life

Jeff Lansing

Approved for public release.

SSC Pacific
San Diego, CA 92152-5001

SSC Pacific
San Diego, California 92152-5001

M. K. Yokoyama, CAPT, USN
Commanding Officer

W. R. Bonwit
Executive Director

ADMINISTRATIVE INFORMATION

The work described in this report was performed for Distributed Common Ground System - Navy (DCGS-N) by the Intelligence Collection Tools Branch (Code 56250) of the ISR Division (Code 56200), Space and Naval Warfare Systems Center Pacific (SSC Pacific), San Diego, CA.

Released by
Laben F. Fisher, Head
Intelligence Collection Tools Branch

Under authority of
Craig A. Wilgenbusch,
Head ISR Division

EXECUTIVE SUMMARY

A pattern of life is an observable manifestation of an underlying regularity in human behavior. The operation of social mechanisms provided in this report explain how such manifestations can depend on the activities and interactions of individuals.

Diagrams and other representational models are shown throughout this report to help bring an understanding of the workings of such mechanisms and their relationships to the patterns of life that they are responsible for. Additionally, this report focuses on approaches to understand and measure the regularity of the responsible mechanisms.

This page intentionally left blank.

ACRONYMS

ACCM	Alternative Compensatory Control Measures
AEA	Atomic Energy Act
C	Confidential
CAPCO	Controlled Access Program Coordination Office
CDO	Controlling Dod Office
CNWDI	Critical Nuclear Weapon Design Information
COMINT	Communications Intelligence
CTS	COSMIC Top Secret
CUI	Controlled Unclassified Information
DCID	Director of Central Intelligence Directive
DEA	Drug Enforcement Administration
DIDO	Designated Intelligence Disclosure Official
DNI	Director of National Intelligence
DoDD	DoD Directive
DoDI	DoD Instruction
DOE	Department of Energy
DoS	Department of State
DUSD(I&S)	Deputy Under Secretary of Defense, Intelligence and Security
DTM	Directive-Type Memorandum
DVD	Digital Video Disc (also Digital Versatile Disc)
E.O.	Executive Order
EXDIS	Exclusive Distribution
FDO	Foreign Disclosure Officer
FGI	Foreign Government Information
FISA	Foreign Intelligence Surveillance Act
FOUO	For Official Use Only
FRD	Formerly Restricted Data
FSE	File Series Exemption
G	Gamma
HCS	HUMINT Control System
HUMINT	Human Intelligence
HVSACO	Handle via Special Access Channels Only
IAW	In Accordance With
IC	Intelligence Community
ICD	Intelligence Community Directive
IT	Information Technology
IMCON	Controlled Imagery
ISCAP	Interagency Security Classification Appeals Panel
ISO	International Organization for Standardization
ISOO	Information Security Oversight Office
JWICS	Joint Worldwide Intelligence Communications System

This page intentionally left blank.

CONTENTS

EXECUTIVE SUMMARY	iii
ACRONYMS.....	v
1. INTRODUCTION.....	1
1.1 OVERVIEW	1
2. CHARACTERIZING PATTERNS OF LIFE	1
3. SOCIAL MECHANISMS	3
4. REPRESENTING PATTERNS OF LIFE	5
4.1 REPRESENTING PHENOMENA	6
4.2 REPRESENTING EXPLANATORY RELATIONS	7
4.3 REPRESENTING MECHANISMS	10
4.4 REPRESENTING EXCEPTIONS	12
5. CHARACTERIZING REGULARITIES	15
6. CONCLUSION.....	17
REFERENCES	19

Figures

1. The Coleman diagram. From [22]	5
2. A correlation ($r = 0.99789$) between two social factors, from [19].....	7
3. The research context of [3]. The dashed arrows and the grey node were open research questions.....	8
4. A simplified illustration of the feedback regulation of the period gene. A) Both period mRNA and PER protein oscillate, with PER protein accumulating several hours after the peak in period mRNA. PER protein localizes in the nucleus, and the period gene activity oscillates as a result of PER protein feedback inhibition of its own gene. B) Additional proteins are essential for the oscillation of the period gene. TIM protein, encoded by the timeless gene is also oscillating and interacts with PER protein. The interaction is critical for PER protein nuclear accumulation and repression of the period gene. DBT protein is encoded by the double-time gene. DBT is a protein kinase that phosphorylates PER, leading to PER protein degradation. DBT-mediated PER protein degradation contributes to the delay between period mRNA and PER protein accumulation. CLK and CYK, encoded by the clock and cycle genes, are two transcription factors that activate the period gene. [After 16]	11

5. Examples of parallel and alternate chains in disease mechanisms. (B) A mechanism chain diagram for a cancer gene variant in the human gene MSH2. From reference [5]. Light cyan rectangles represent phenomena and yellow hexagon elements represent mechanisms. Grey hexagon elements represent as yet unknown mechanisms. Yellow lines and arrows indicate uncertainty 14

1. INTRODUCTION

1.1 OVERVIEW

Existing characterizations of patterns of life [4], [6] do not provide enough information to determine what a representation of a pattern of life would actually have to represent, in order to be adequate or useful. Nor do they provide criteria that might be used to distinguish spurious patterns of life from real ones. Based on the existing work, the characterization of patterns of life provided below tries to fill in these gaps.

Section 2 provides a characterization that facilitates both representing patterns of life and a way of verifying their existence. Patterns of life are characterized in terms of mechanisms, following a style of thinking that is becoming common across the sciences, in medicine, and elsewhere. In this way of thinking “a mechanism for a phenomenon consists of entities and activities organized in such a way that they are responsible for the phenomenon” [9, Page 119], where a phenomenon is something observable. Section 3 discusses the kinds of mechanisms that are adequate for explaining patterns of life. Section 4 discusses representations of patterns of life based on the characterization from Section 2, and also discusses exceptions to such patterns. Section 5 presents a tentative approach to the tricky issue of how much and in what way the operation of a mechanism has to be regular, in order to count as a pattern of life. Section 6 concludes with a summary of content presented.

2. CHARACTERIZING PATTERNS OF LIFE

A *pattern of life* is an observable manifestation of an underlying regularity in human behavior. Here human behavior is meant in the broadest sense to refer to the behavior of individual people, of groups, teams, crowds, and organizations of people, and—more abstractly—of cultures and societies; the term *actor* will be used to refer to any of these.¹ And behavior is meant to refer to some meaningful activity or activities of actors, and those activities are assumed to be composed of simpler actions by actors,² some of which can actually be observed.³ In what follows the term *entity* will be used to refer to a broader category that includes actors, their equipment, and features in their environment. Most behaviors are interactions between and among multiple entities, some of which will be actors; all behaviors last through some period of time; some behaviors are regular. Finally, the term *phenomenon* is popularly used to refer to observed happenings that are somehow attention-getting, perhaps because they are unusual or otherwise notable. And so in these terms a pattern of life can also be characterized as a phenomenon that is brought about by the activities and interactions of some entities that are related to that phenomenon, where the right kind of regularity is involved.

¹ It makes sense here to regard lower-level actors, such as teams, as parts of higher-level actors, such as organizations.

² And it makes sense here to regard actions as mainly temporal parts of activities.

³ Careful consideration shows that behaviors are also organized by a different relation (other than parthood), in which higher-level behaviors occur because other lower-level behaviors are also occurring. This is pointed out in [4].

Different kinds of regularity will be discussed in Section 5. But for now it should be noted that regularity is important because exceptions to or deviations from regular behavior can be informative. For example: “the Abbottabad compound suggested immediately the possibility that bin Laden was living there. Extraordinarily high walls, barbed wire, no telephone or Internet service, trash burned instead of put out for collection like everybody else’s, children not going to school.” [17] Here obviously the informative exceptions included burning the trash inside the compound instead of putting it out for collection and keeping the children out of school instead of sending them, and the regular behaviors in this example would be just what everybody else did. Such exceptions to regularity are discussed in Section 4.4. Finally, an observable manifestation—a phenomenon—is not only something that gets attention, but also something that calls for an explanation. The next section discusses a way of explaining the phenomena known as patterns of life.

3. SOCIAL MECHANISMS

If regular behavior is what everybody—apart from exceptions like the bin Laden Abbottabad compound—does, then what is it that they actually do, that results in some observable pattern? For the specific behavior of putting trash out for collection, something more can be said about this.

In general, every household produces a surplus of solid waste in the forms of organic garbage, paper, plastic, glass, and metal (in roughly that order). And in general, every community of households has organized ways of processing that surplus. Locally, each household can participate in this organization in different ways. But there are patterns. Survey data [10] indicates that in urban areas of Abbottabad, 12% of households report being serviced by door-to-door municipal trash collectors, and 47% report that municipal workers collect garbage in their areas and carry it to designated collection points, while in rural areas only 3% of households benefit from this collection service.⁴ Additionally, the same survey suggests that up to 90% of households are also served by an informal Kabari system of trash recycling.⁵ Since the Bilal neighborhood of Abbottabad where the bin Laden compound was located is a higher class area⁶, it is likely that it was part of the 47%, and possibly even the 12%.

Statistics show differences in trash collection participation in Abbottabad, and the hypothesis here is that this correlates locally with other social factors. But what could explain a connection between the general social status of a neighborhood, or the general cost of construction of the houses there, and the regular participation of the households located in that neighborhood in some form of trash collection system (either municipal or informal)? What connects social variables or factors like class status, wealth, community, neighborhood, and household with trash collection systems (which themselves involve interacting social variables like funding, competition, bribery, and class status)? Where is the pattern?

⁴These 3% are households of influential individuals who reside in the outskirts of town [10].

⁵“Scavengers and scrap dealers (kabarīs) ... collect reusable materials from garbage dumps or purchasing such items directly from households. ... Theirs is a significant contribution to waste management in the district.” [10]

⁶“Abbottabad is known ... for its ... well-regarded schools and colleges.... Bilal Town is one of its most upscale neighborhoods, an area with large, sometimes garish houses and open fields” [18].

One way to arrive at the kind of explanation that is called for here is to look for social mechanisms, and to find regularities in the operation of these mechanisms. In mechanistic explanations in general the occurrence of phenomena, such as patterns, is explained as the operation of mechanisms, and mechanisms are just bounded collections of actors interacting in some organized way [9]. For social mechanisms in particular, this kind of explanation has a further degree of organization into three parts. When successful, then the operation of the social mechanism shows how higher-level (“macro”) social facts are grounded in lower-level (“micro”) facts, which in turn bring about other lower-level facts, which then in turn underlie some other higher-level facts, which were to be explained.

Instead of analyzing relationships between phenomena exclusively on the macro level, one should (1) identify the *situational mechanisms* by which the macro environments in which actors are embedded—organizations, fields, networks, etc.—shape actors’ opportunities, goals, beliefs, etc., as well as (2) *the action-formation mechanisms* that show how these opportunities, goals, beliefs, etc. influence the actors behavior, and finally (3) the *transformational mechanisms* that show how the behavior of many individuals jointly brings about various intended and unintended macro outcomes. Only by considering the entire chain of situational, action-formation, and transformational mechanisms, have we explained the observed macro phenomenon [7, page 94].

So for the Bilal case, the situational mechanism might talk about how rising class status is correlated with acceptance of “modern” waste management systems, the action-formation mechanism might explain how acceptance leads to arranging for the servants to get the trash to the collectors, and the transformational mechanism might explain how the collective behavior of household servants leads to observable participation in some trash collection system. This makes sense, but actually filling in all the details is hard, and requires training. Nevertheless, this example shows a case where the operation of a mechanism can explain a pattern—something observable, and where exceptions to the pattern can be significant.

4. REPRESENTING PATTERNS OF LIFE

In Section 2 a pattern of life was characterized as an observable manifestation of something, and Section 3 suggested that such manifestations were constituted by the operations of organized activities and interactions of social actors. And further, it was suggested that some kind of regularity was involved, in order to justify calling the observable phenomenon a *pattern*. This section discusses how representations or models can be useful for both discovering and then presenting:

1. phenomena,
2. the relations between phenomena and their underlying mechanisms, and
3. the mechanisms themselves, and their operation.

Examples of such representations, especially diagrammatic representations—charts, graphs, and other kinds of diagrams—will be presented in the following subsections. For social mechanisms the most common diagram is the Coleman diagram [22], shown in Figure 1.

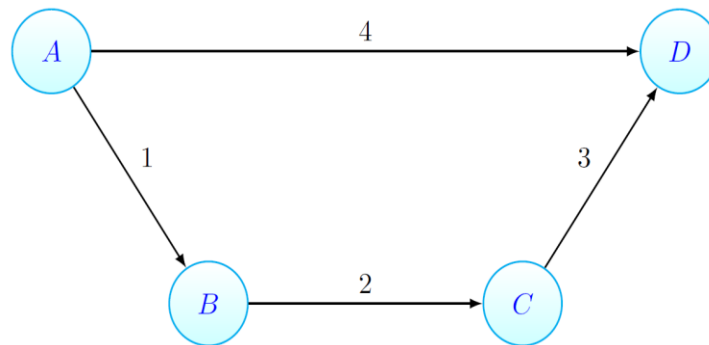


Figure 1. The Coleman diagram. From [22].

The intent of the Coleman diagram is to represent a social mechanism, that is, to illustrate how an observed social relation between nodes A and D in the diagram can be explained by following an explanatory path through nodes B and C. There are four kinds of nodes in the diagram, which are distinguished by both the level at which they participate and also by the two ways (vertically and horizontally) in which they participate in the explanation. A nodes are considered to be higher-level social factors that might determine social phenomena and that also might influence lower-level actors. D nodes are social factors that seem to correlate with A nodes. A nodes and D nodes are characteristics of the social environments or social contexts of the lower-level actors. B nodes represents characteristics of actors and their situations. Examples of such characteristics are “beliefs, desires, goals, values, preferences, motives, emotions, habits, routines, scripts, heuristics, cognitive schema, and identities.” [22, page 6] C nodes represent behavioral outcomes, which can be choices, behaviors, or actions. C factors both result from B factors and are important for explaining D factors. The arrows in the Coleman diagram refer to the three parts of the overall mechanism, as mentioned in Section 3. Reference [22, page 20] points out that the original use of the diagram was to emphasize the importance of arrow 3, the transformational mechanism. It is often assumed that social D factors are

merely aggregates of many individual C factors, but a number of clear results show how this assumption is wrong in even very simple settings. The diagram shows where in the larger argument this erroneous assumption lies, and thus points out which mechanism discovery steps need to be refined. Thus the diagram helps a researcher to think more clearly about where weaknesses in the overall explanation occur.

4.1 REPRESENTING PHENOMENA

In a number of areas of science (and also in medicine) mechanism discovery precedes by creating different, and different kinds of, diagrams during different phases of the process. In [1] these three kinds of diagrams are referred to as phenomenon diagrams, explanatory relations diagrams, and mechanism diagrams. A phenomenon diagram is used to represent some observed relation, potentially corresponding to arrow 4 in a Coleman diagram. A phenomenon diagram is often a simple line graph, as in Figure 2.

Figure 2 shows a clear pattern: whenever there is a change in spending there is a corresponding change in the suicide rate, and the correlation is strongly positive. But is this pattern really a pattern of life?⁷ According to the characterization given in Section 2, the answer is: not yet. What is still missing is the connection to some social mechanism that would bring about this pattern, regularly enough to explain the strong correlation. In other words (i.e., in Coleman diagram terms) what is missing are the B factors and the C factors, and the three component explanations for arrows 1, 2, and 3. Only then would Figure 2 become a representation of a real pattern of life, rather than just a spurious correlation.

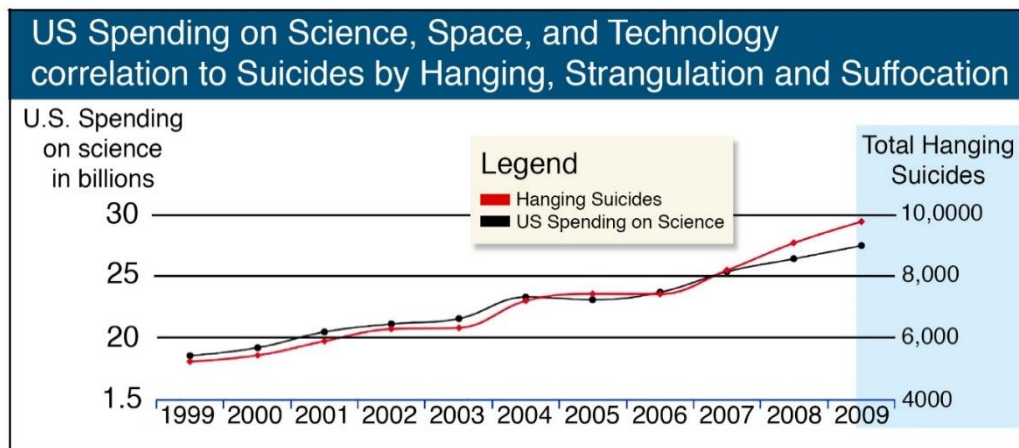


Figure 2. A correlation ($r = 0.99789$) between two social factors, from [19].

4.2 REPRESENTING EXPLANATORY RELATIONS

The next step in mechanism discovery is to find correlations between the factors that form the pattern to be explained and other factors that can be part of an explanation for the pattern. These other correlations are called explanatory relations, and they can be inspected for clues about missing parts of a potential explanation by looking at diagrams which represent what is known so far about the mechanism in question. In order to continue following the development in [1], this subsection (and the following one) will switch from a “sociological” example, where the higher level involves social groups and the lower level involves individuals, to a “biological” example, where the higher level involves organized groups of cells, and the lower level involves individual cells. Conveniently, the biological example focuses on exactly those aspects of the daily behavior of all living organisms which form patterns, of which there are many.

An explanatory relation diagram is much like a phenomenon diagram, but it has a different purpose. “What makes a particular diagram explanatory is that one or more of its variables is not among those portraying the phenomenon but is causally linked to it—often due to its role in an existing or emerging mechanistic explanation” [1, page 123]. Figure 3 shows how the Coleman diagram represents such linked variables.

⁷ The point of the original Figure 2 seems to be to show that appearances are deceptive, because intuitively the correlated factors cannot possibly be related. But the point could just as well be that untrained intuition is weak, and isn’t very good at finding explanatory relations.

Reference [3] was an investigation that tried to show that *population encoding* was an explanatory relation that could explain how a “team” of neurons in a small area of the brain could regulate the daily behavior of laboratory mice as precisely as it does. Reference [1] uses this work as their primary example of mechanism discovery in action. By the time that the work in [3] was being performed, researchers already knew that:

1. in general, most living organisms exhibit circadian behavior;⁸
2. individual cells in the organs of mammals contain autonomous molecular genetic circadian clocks that drift unless they are entrained (i.e., synchronized) somehow by a master clock, or “pacemaker”;
3. that a small area of the hypothalamus, called SCN⁹, is where the master clock is located;
4. that the tens of thousands of neurons in the SCN must be synchronized among themselves in order for the SCN to function as a master pacemaker for the rest of the organism.

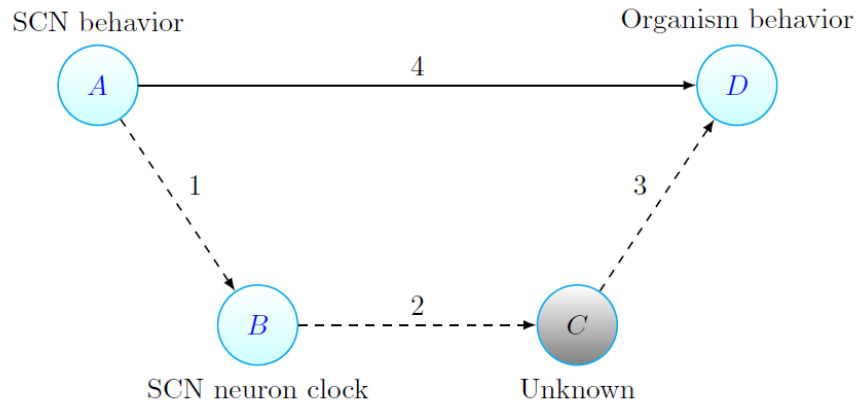


Figure 3. The research context of [3]. The dashed arrows and the grey node were open research questions.

⁸“The period of a biological rhythm is tied to the 24-h rotational movement of the Earth. Organisms across different domains of life evolved timing mechanisms called biological clocks to coordinate function and behavior to specific times of the day. Each day environmental cues such as light and temperature reset your biological clock in a process called entrainment.” [12]

⁹The suprachiasmatic nucleus (SCN) contains 20K neurons. It receives information about ambient light from the eyes.

So in terms of the Coleman diagram in Figure 3, the A nodes represent the “social behavior” of the neurons in the SCN, and the D nodes represent circadian behaviors of the organism¹⁰, arrow 4 represents the relation to be explained, and the dotted lines in the diagram shows just how much of the social mechanism remained to be explained, at the time of [3].

The B nodes are clearly the individual autonomous circadian clocks of the SCN neurons, and C nodes are the circadian clocks in the cells somewhere (unknown) in the tissues of the organs in the rest of the body of the organism. Some things are known about the relation shown by arrow 2 in the diagram: control signals flow from the SCN neurons through both sympathetic and parasympathetic pathways. [13] Arrow 3 is mostly an unknown.¹¹ And arrow 1 in the Coleman diagram is what the researchers in [3] were trying to understand: how does the organization of the neurons in the SCN synchronize the individual clocks in those neurons?

The authors of [3] used an elaborate series of measurement techniques in order to produce information that they could represent in different kinds of phase diagrams, and they argued that the patterns seen in those diagrams was characteristic evidence of population encoding. Time has shown that the organization of the SCN is more intricate than the authors of [3] must have imagined, but the point remains that researchers discover—or attempt to discover—mechanisms using intermediate constructs, represented diagrammatically, that they hope will lead to complete mechanisms.

¹⁰ Such as wheel running by laboratory mice in experiment [3].

¹¹ How for example, would the activity of the individual cellular circadian clocks be organized so that it would affect the circadian wheel-running behavior of laboratory mice?

4.3 REPRESENTING MECHANISMS

Once the picture of the mechanism underlying a pattern begins to emerge, diagrams of the mechanism itself become an important part of the investigation. Although the overall mechanism represented in Figure 3 is still mostly unknown, the B node mechanism (i.e., the neuron clock) was discovered in the 1990's and has been since refined.

The Nobel Prize in Physiology or Medicine 2017 was awarded jointly to Jeffrey C. Hall, Michael Rosbash and Michael W. Young “for their discoveries of molecular mechanisms controlling the circadian rhythm” [15]. The Nobel Assembly at Karolinska Institute provided advanced information for the 2017 awards ceremony which contained Figure 4, as a representation of the mechanism that the recipients had discovered. The discovery was essentially that a fact from systems theory—that a negative feedback loop produces oscillations—was actually realized in a molecular genetic mechanism within living cells.

Figure 4.A shows what was discovered in 1990 by the prize winners, and Figure 4.B shows a number of additional factors which are now known to regulate the oscillation to make it occur approximately daily. The authors of [1] comment that:

the two mechanistic diagrams in Figure 4 provide just a glimpse of the diverse formats, styles, and uses of mechanistic diagrams not only by circadian researchers but across a broad range of fields. They are ubiquitous in laboratories: stacked on desks, inserted into lab notebooks, drawn on whiteboards with warnings not to be erased, and so forth. These diagrams support scientists' cognitive activities as they develop mechanistic explanations and revise them in the light of new findings. Some are used as well for communication and interaction within the research group or in presentations. A very small number get published.[1, page 129]

So if patterns of life depend on the underlying “social” mechanisms that are responsible for them, then can understanding the workings of those mechanisms, using diagrammatic representations, lead to understanding of the corresponding patterns of life? If the behavior of scientists is any indication, then it seems that the answer here is yes.

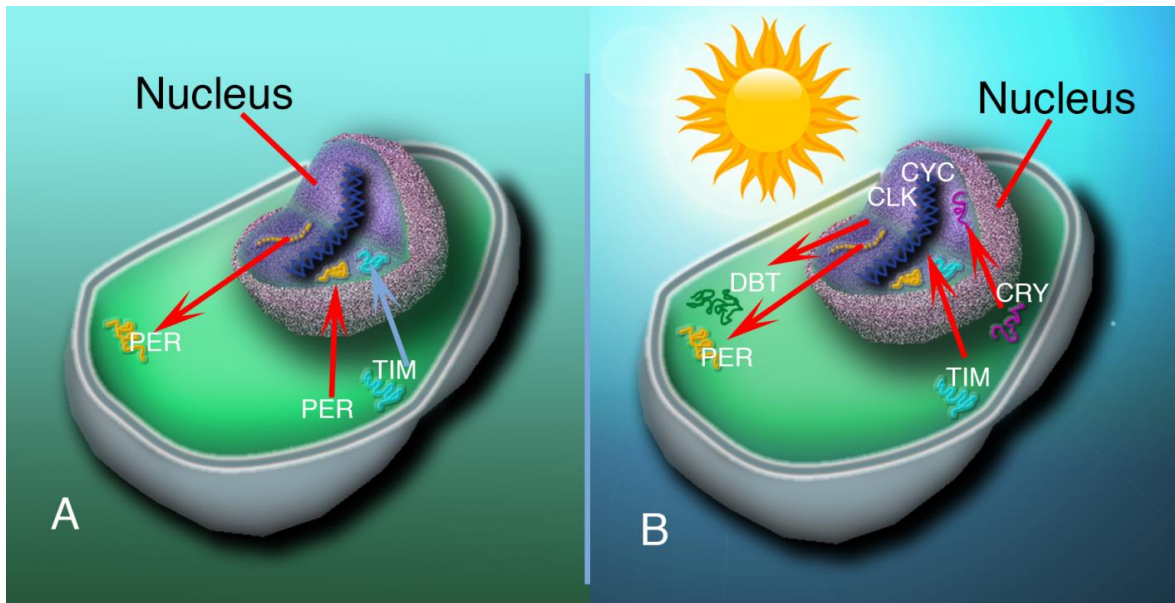


Figure 4. A simplified illustration of the feedback regulation of the period gene. A) Both period mRNA and PER protein oscillate, with PER protein accumulating several hours after the peak in period mRNA. PER protein localizes in the nucleus, and the period gene activity oscillates as a result of PER protein feedback inhibition of its own gene. B) Additional proteins are essential for the oscillation of the period gene. TIM protein, encoded by the timeless gene is also oscillating and interacts with PER protein. The interaction is critical for PER protein nuclear accumulation and repression of the period gene. DBT protein is encoded by the double-time gene. DBT is a protein kinase that phosphorylates PER, leading to PER protein degradation. DBT-mediated PER protein degradation contributes to the delay between period mRNA and PER protein accumulation. CLK and CYC, encoded by the clock and cycle genes, are two transcription factors that activate the period gene. [After 16]

4.4 REPRESENTING EXCEPTIONS

Section 2 pointed out the importance of exceptions to patterns of life: the bin Laden compound in Abbottabad stood out for analysts precisely because it did not fit with the local patterns of life. But what does “not fit with” mean, really? This section looks at that question and tries to extend the mechanism-based methodology for investigating patterns of life to the investigation of their exceptions.

Once a pattern has been shown to be connected to an underlying mechanism, and the workings of the mechanism itself have been illustrated—i.e., once a pattern of life has been shown—then what about exceptions to the pattern? Here too representations are helpful, and for similar reasons. One area where the investigation of exceptions is important, because it now matters or will matter to everyone, is medicine. On one view, if the typical pattern of life is *health*, then *disease* becomes an exception to that pattern. On this view—called the “broken normal” view—disease is characterized as a “normal” healthy mechanism, but with some broken parts and/or some broken interactions. This view, while intuitively appealing, has been criticized on several grounds, including its reliance on the notion of “normal”. An influential alternative view, proposed in [14], reverses the perspective on characterizing disease. This alternative view notes that over the course of time medical research fills in the details of how healthy mechanisms operate by examining the details of how disease mechanisms operate. In doing this, most exceptions turn out to be mere *anomalies* and are ignored, but some are actual *abnormalities*, and are taken as evidence of an underlying pathology.¹² Reference [14] also notes that the behavior of disease mechanisms is different¹³, and proposes that in fact disease mechanisms are built from chains of healthy mechanisms, perhaps suitable altered so as to support the pathologies exhibited by the disease mechanism. Reference [5] presents a form of diagram that has been tailored for representing exceptions to patterns in this sense of abnormality (*versus* anomaly). The idea is that when researchers are investigating the causes of diseases, they are really constructing or refining disease mechanisms in order to understanding precisely where therapeutic interventions can be beneficial, in order to restore health. Figure 5 shows two such disease mechanisms, and as is apparent from the figure, disease mechanisms are structurally more complex than healthy mechanisms in that they may contain both alternate and paralleled chains of embedded mechanisms.

¹² Reference [14] calls healthy mechanisms “physiological mechanisms” and it calls disease mechanisms “pathological mechanisms”.

¹³ In particular, it points out that

- the outcome of disease mechanisms is variable, but the outcome of healthy mechanisms is regular;
- disease mechanisms are less constrained by dependable background conditions than healthy mechanisms are; and
- disease mechanisms are ambivalent, where healthy mechanisms are always beneficial.

Returning to the example of bin Laden’s Abbottabad compound, how might the representation technique of Figure 5 be applied? First, exceptions like burning the trash inside the compound and keeping the children out of school, instead of being treated as anomalies, would be treated as evidence of underlying social pathology.¹⁴ Second, general properties of pathological social mechanisms—such as cults, cartels, and the Camorra, and of how they are constructed from chains of suitably altered “healthy” social mechanisms, would be brought to bear. And third, for the particular case at hand, a diagram such as the ones in Figure 5 would be developed, connecting the observed abnormalities to the candidate pathological mechanism.

¹⁴ It has been reported that bin Laden’s neighbors assumed that the compound’s occupants were devout religious conservatives, and might therefore have kept the children out of school in order to keep foreign or “Western” ideas out. Evidently this pattern of behavior was subverted in this case, in order to keep information in.

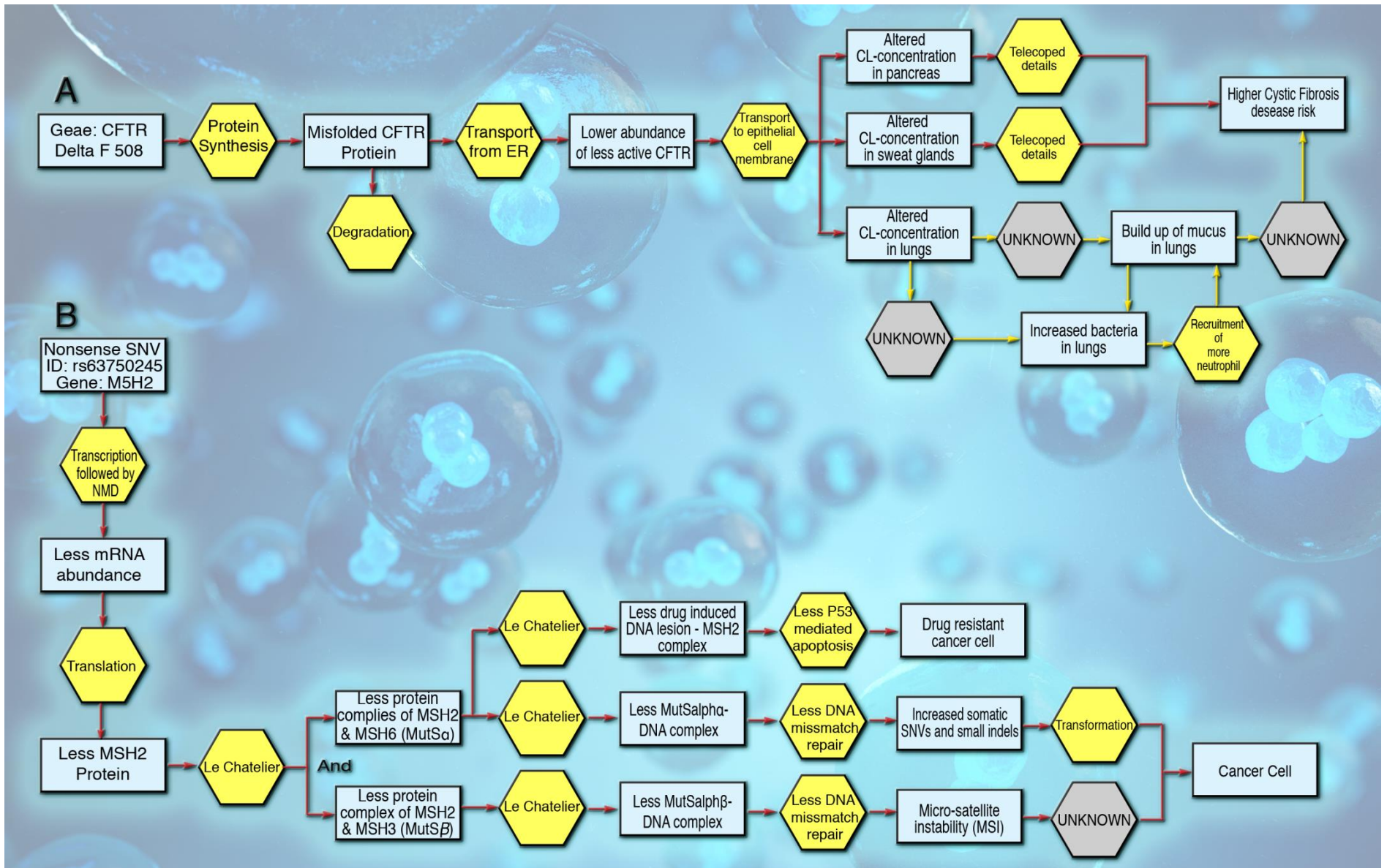


Figure 5. Examples of parallel and alternate chains in disease mechanisms. (B) A mechanism chain diagram for a cancer gene variant in the human gene MSH2. From reference [5]. Light cyan rectangles represent phenomena and yellow hexagon elements represent mechanisms. Grey hexagon elements represent as yet unknown mechanisms. Yellow lines and arrows indicate uncertainty

5. CHARACTERIZING REGULARITIES

A number of people have observed that regular behavior is not necessarily something that occurs always or most of the time. Even for the bin Laden compound trash collection case, it seems as if the relevant regularity might only be occurring 12% of the time. So if regularity is not typicality¹⁵ or normality, then what is regularity, really? A tentative approach to answering this question might begin by asking how regularity could be measured. This approach would then try to characterize regularity by looking at whether regularity is a measurable property of mechanisms, and if so, then what kind of measurement process would be applicable to it. An important observation comes from reference [2], which examines in detail the locations within the operation of a mechanism where regularity can occur. These are:

1. Regular occurrence of startup conditions,
2. Regular triggering of the mechanism once startup conditions occur,
3. Regular operation of specific activities connecting the entities within a single mechanism,
4. Regular production of termination conditions once the mechanism has been triggered.

This is a partial list, and reference [11] adds:

5. Regular occurrence of the connection between the mechanism and the phenomenon that it explains.

So it seems that different measurements of regularity can come from different organizational locations in the overall structure of a mechanism. And the next question would then be: how do these different measurements combine together, to give an overall measurement of the regularity of the whole mechanism?

A clue here comes from looking at the relative regularity of related mechanisms. Potential cases of related mechanisms that might show relative regularity are described in earlier sections of this paper:

1. Disease mechanisms are constructed from chains of suitably modified healthy mechanisms and it is plausible that in order for some disease mechanisms to operate, the operation of the underlying healthy mechanisms must be more regular than the operation of the disease mechanism.
2. Circadian rhythms in living organisms are entrained to ambient rhythms in the organism's environment such as the daily rhythms of light and darkness caused by the rotation of the earth, and it is plausible that in order for the circadian rhythms to fulfil their functional role, the ambient rhythms have to be more regular than the inherent rhythms in the organism's circadian clocks.

¹⁵“The concept of typicality refers to properties holding for the vast majority of cases.” [20]

Relative regularity provides some clue, but that clue is ambiguous. It could be indicating that regularity is a property like *hardness*, and can only be measured comparatively. Or it could be that different measures of regularity combine together multiplicatively, so that the overall measure is never greater than any of the individual measures.

As suggested at the beginning of this section, this is all quite preliminary, and much research remains to be done. Some recent research in [11] looks at how the regularity of token operations of a mechanism accumulates into the regularity of the mechanism type, and suggests that a frequentist approach would be appropriate.¹⁶ This is another piece of the puzzle, but beyond that not much else seems to be known.

¹⁶ This result could be indicating that regularity is a property like *quality*, and that quality control techniques such as statistical sampling could be brought to bear here.

6. CONCLUSION

This paper has looked at patterns of life, and at exceptions to those patterns, and has tried to follow a program which moves away from characterizing meaning by examining analytical definitions of concepts or structures of concepts, and moves toward using actually occurring parts of nature, and our observations of those occurrences and parts, in order to construct explanations. So the central idea followed here was that *mechanisms* are things in the world, and that the existence of such mechanisms can explain patterns of life and can also explain exceptions to patterns of life. Patterns of life are explained by social mechanisms. Some individual daily patterns are explained by circadian mechanisms. And interesting exceptions are explained by complex chains of suitably modified embedded mechanisms.

The flavor of the ideas presented here should seem familiar to any systems engineer. And indeed, most mechanism talk can be easily converted into systems talk:

- the systems black-box view corresponds to the notion of a phenomenon,
- the white-box view corresponds to the description of the mechanism that is responsible for the phenomenon,
- the nesting of subsystems inside systems corresponds to the notion of embedded mechanisms,
- and so on.

But the emphasis is different. According to [21]

The term “system” refers to very general characteristics partaken by a large class of entities conventionally treated in different disciplines. Hence the interdisciplinary nature of general systems theory; at the same time, its statements pertain to formal or structural commonalities abstracting from the “nature of elements and forces in the system” with which the special sciences (and explanations in these) are concerned. In other words, system-theoretical arguments pertain to, and have predictive value, inasmuch as such general structures are concerned. [page 416.]

On the other hand, “mechanism” refers to specific instances of things that actually have occurred or are occurring in the world, and a broad range of scientists, technicians, and other use the term “mechanism” in just this way. So the emphasis is more on how individual things work and less on general principles that might apply more widely.

So in summary, the intent of this paper has been to provide a naturalized rather than a conceptual—characterization of patterns of life in terms of mechanisms, and it succeeds or fails at that just to the extent that the proposed mechanisms exist, or fail to do so.

This page intentionally left blank.

REFERENCES

1. Abrahamsen, A. and Bechtel, W. 2015. "Diagrams as Tools for Scientific Reasoning," *Review of Philosophy and Psychology*, vol. 6, no. 1, pp. 117–131. DOI: 10.1007/s13164-014-0215-2. Available online at <https://mechanism.ucsd.edu/research/abrahamsenandbechtel.Diagrams%20as%20Tools%20for%20Scientific%20Reasoning.final.pdf>. Accessed August 29 2018.
2. Andersen, H. 2012. "The case for regularity in mechanistic causal explanation," *Synthesis* vol. 189 no. 3, pp 415432. DOI: 10.1007/s11229-011-9965-x. Available online at <https://link.springer.com/article/10.1007/s11229-011-9965-x>. Accessed August 29, 2018.
3. Ciarleglio C.M., Gamble K.L., Axley J.C., Strauss B.R., Cohen J.Y., Colwell C.S., and McMahon D.G. 2009. "Population Encoding by Circadian Clock Neurons Organizes Circadian Behavior," *Journal of Neuroscience*, vol. 29, no. 6, pp. 1670–1676. DOI: 10.1523/JNEUROSCI.3801-08.2009. Available online at <https://www.ncbi.nlm.nih.gov/pubmed/19211874>. Accessed August 29, 2018
4. Craddock R., Watson D., and Saunders W. 2016. "Generic Pattern of Life and Behavior Analysis," *IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA)*. Available online at <https://zapdf.com/generic-pattern-of-life-and-behaviour-analysis.html>. Accessed August 29, 2018.
5. Darden, L., Pal L. R., Kundu, K., and Moul, J. 2018. "The Product Guides the Process: Discovering Disease Mechanisms," in *Building Theories: Heuristics and Hypotheses in Sciences*, Danks, D. and Ippoliti, E. eds., Springer, pp. 101–117. DOI: 10.1007/978-3-319-72787-5. Available online at <http://philsci-archive.pitt.edu/13176/>. Accessed August 29, 2018.
6. Folsom-Kovarika J.T., Schatzb S., Jonesa R.M., Bartlett K., and Wraya R.E. 2013, "Scalable Models for Patterns of Life." *Proceedings of the Twenty-Fifth Innovative Applications of Artificial Intelligence Conference*. Available online at <http://www.aaai.org/Conferences/IAAI/2014/6434-30444-1-PB.pdf>. Accessed August 29, 2018.
7. Hedström, P. and Wennberg, K. 2017, "Causal mechanisms in organization and innovation studies," *Innovation*, vol. 19 no. 1, pp. 91-102. DOI: 10.1080/14479338.2016.1256779. Available online at <https://www.dandfonline.com/doi/pdf/10.1080/14479338.2016.1256779> Accessed August 29, 2018.
8. Herzog E. D., Hermanstyn T. O., and Hastings M. H. 2017. "Regulating the Suprachiasmatic Nucleus (SCN) Circadian Clockwork: Interplay between Cell-Autonomous and Circuit- Level Mechanisms," *Cold Springs Harbor Perspectives in Biology*, vol. 9 no. DOI: 10.1101/cshperspect.a027706. <http://cshperspectives.schlp.org/content/9/1/a027706.full>.
9. Illari, P. M. and Williamson, J. 2012. "What is a Mechanism?: Thinking about mechanisms across the sciences," *European Journal for Philosophy of Science*, vol. 2 no. 1, pp. 119-135. DOI: 10.1007/s13194-011-0038-2. Available online at <https://link.springer.com/article/10.1007%2Fs13194-011-0038-2>. Accessed August 29, 2018.
10. IUCN Pakistan .2009. "Environmental Fiscal Reform in Abbottabad: Solid Waste Management," IUCN Pakistan, Islamabad, Pakistan. iv+20. Available online at <https://portals.iucn.org/library/node/9738>. Accessed August 29, 2018

11. Krickel, B. .2017. “A Regularist Approach to Mechanistic Type-Level Explanation,” *The British Journal for the Philosophy of Science*, axx011. DOI: 10.1093/bjps/axx011. Available online at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465137/>. Accessed August 29, 2018.
12. Milius, A. and Ueda, H. R. .2017. “Systems Biology-Derived Discoveries of Intrinsic Clocks,” *Frontiers in Neurology*, vol. 8 no. 25, pp. 1–19. DOI: 10.3389/fneur.2017.00025. Available online at <https://europepmc.org/abstract/med/28220104>. Accessed August 29, 2018.
13. Mohawk J. A., Green C. B., and Takahashi J. S. 2012. “Central and Peripheral Circadian Clocks in Mammals,” *Annual Review of Neuroscience*, vol. 35, pp. 445-462. DOI: 10.1146/annurevneuro-060909-153128. Available online at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3710582/>. Accessed August 29, 2018.
14. Nervi, M. 2010, “Mechanisms, Malfunctions and Explanation in Medicine,” *Biology and Philosophy*, vol. 25 no. 2, pp. 215-228. DOI: 10.1007/s10539-009- 9190-x. Available online at <https://link.springer.com/article/10.1007/s10539-009-9190-x>. Accessed August 29, 2018.
15. Nobel Prize .2017a. “The Nobel Prize in Physiology or Medicine 2017”, Nobelprize.org, Nobel Media AB 2014. Available online at http://www.nobelprize.org/nobel_prizes/medicine/laureates/2017/. Accessed August 29, 2018.
16. Nobel Prize .2017b. “The 2017 Nobel Prize in Physiology or Medicine - Advanced Information: Discoveries of Molecular Mechanisms Controlling the Circadian Rhythm”, *Nobelprize.org*, Nobel Media AB 2014. Available online at http://www.nobelprize.org/nobel_prizes/medicine/laureates/2017/advanced.html. Accessed August 29, 2018.
17. Stephen W. Preston. 2012. “CIA and the Rule of Law,” *Journal of National Security Policy and Law*, vol. 6 no. 1. Available online at <https://heinonline.org/HOL/LandingPage?handle=hein.journals/jnatselp6&div=2&id=&page=>. Accessed August 2018.
18. Saeed Shah, 2 May 2011. “Bin Laden’s ‘neighbors’ profess ignorance of his presence,” *McClatchy Newspapers*. Available online at <https://www.mcclatchydc.com/news/nation-world/world/article24628054.html>. Accessed August 2018.
19. Vigen, T. 2015. “Spurious Correlations,” Available online at <http://www.tylervigen.com/spurious-correlations>. Accessed August 2018.
20. Volchan, S. 2007. “Probability as Typicality”, *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*,” vol. 38 no. 4, pp. 801–814. DOI: 10.1016/j.shpsb.2006.12.001.
21. Von Bertalanffy, L. 1972. “The History and Status of General Systems Theory,” *Academy of Management Journal*, vol. 15 no. 4, pp. 407-426. DOI: 10.2307/255139. Available online at <https://journals.aom.org/doi/10.5465/255139>. Accessed August 29, 2018.
22. Ylikoski, P. 2016. “Thinking with the Coleman Boat,” Available online at <https://liu.diva-portal.org/smash/get/diva2:1048216/FULLTEXT02.pdf>. Accessed August 29, 2018

INITIAL DISTRIBUTION

84300	Library	(1)
85300	Archive/Stock	(1)
56250	J. Lansing	(1)

	Defense Technical Information Center	
	Fort Belvoir, VA 22060-6218	(1)

REPORT DOCUMENTATION PAGE

*Form Approved
OMB No. 0704-01-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden to Department of Defense, Washington Headquarters Services Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) September 2018		2. REPORT TYPE Final	3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Patterns of Life			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHORS Jeff Lansing			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) SSC Pacific 53560 Hull Street San Diego, CA 92152-5001			8. PERFORMING ORGANIZATION REPORT NUMBER TD 3354	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Distributed Common Ground System – Navy 4301 Pacific Highway San Diego, CA 92110-3127			10. SPONSOR/MONITOR'S ACRONYM(S) DCGS-N	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release.				
13. SUPPLEMENTARY NOTES This is work of the United States Government and therefore is not copyrighted. This work may be copied and disseminated without restriction.				
14. ABSTRACT A pattern of life is an observable manifestation of an underlying regularity in human behavior. The operation of social mechanisms provided in this report explain how such manifestations can depend on the activities and interactions of individuals. Diagrams and other representational models are shown throughout this report to help bring an understanding of the workings of such mechanisms and their relationships to the patterns of life that they are responsible for. Additionally, this report focuses on approaches to understand and measure the regularity of the responsible mechanisms.				
15. SUBJECT TERMS Coleman diagram; patterns of life; SCN neuron clock; physiological mechanisms; PER protein; mRNA; DBT; disease mechanisms				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	c. THIS PAGE		
U	U	U	U	32
			19a. NAME OF RESPONSIBLE PERSON Jeff Lansing	
			19b. TELEPHONE NUMBER (Include area code) (619) 553-0743	

This page intentionally left blank.

Approved for public release.



SSC Pacific
San Diego, CA 92152-5001