

Impaired Engagement in High-Reliability Organizing (HRO): 4. Situational Cognitive Distortions

Daved van Stralen, MD, FAAP, Sean D. McKay, Thomas A. Mercer, RAdm, USN (Retired)

Abstract:

Rather than describing the environment as a structural entity, the HRO views the environment as the flow of environmental energy. Energy has frequencies, and we can use sound and light to model characteristic energy flow patterns. White light contains all wavelengths of visible light. Long wavelength light (low frequency or long period) is red. Red light has a low frequency but carries more energy. We may better understand individual or organizational responses to risk or hazards if we consider them a response to a specific type, or 'color,' of environmental noise. Our initial response to an adverse or hostile environmental, red noise, is affective – give value to environmental signals and ensure self-protection. How we manage that affective response can augment our cognitive capacity or distort our cognition. It is known that High-Reliability Organizing increases stress capacity and reliability of the organization. What is under-recognized is how this happens: utilization of human affective responses to increase cognitive and stress capacities of individuals, teams, and groups.

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Introduction

One of the authors (DvS) recently visited Germany on a group tour, including the concentration camp at Dachau. Several days before the visit, the tour guide, Michael Dempsey, began minilectures on the coach ride. Topics included German music, art, geography, culture, philosophy, political history, World War II, and the Nazis. Each minilecture answered a question developed during one of the other topics. Initially, the topics seemed disparate. As we approached Dachau, the timeline for the topics began to move up to the 1920s. Then the topics began to merge. As he discussed the 1930s, all the topics merged into one reference frame Dempsey had drawn us into, manifested by an unfair life, financial uncertainty, and with little support. Our guide decontextualized the Nazi experience through almost extreme contextualization, making it transportable to other cultures and circumstances. We learned how a small group could influence the majority of the population.

Their method became recognizable. Take a disliked situation, frame it as a shared threat (even if it is not), then describe the harm it may cause — engender fear of something or someone we routinely encounter. The majority will voluntarily, if not spontaneously, find the cause and ‘fix it.’ That is, the majority now assigns the blame. Encouraging bad people to do bad things is the easy part. Persuading good people to do bad things is the sad part. We do not want to lose our sense of proportion to the tragedy. Neither do we want to lose the most important lesson of the 20th Century.

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We ask if healthcare has excessively focused on the shared threat of medical error and its harm to patients. Extensive discussion of the threat instills self-regulating behaviors to prevent even the appearance of error. The majority then self-regulate through conformity and obedience. Management science assures safety when collected data reduces variance and statistical analysis emerges from the narrowed Gaussian distribution.

We need not sacrifice the benefits of initiative and creativity to secure obedience and conformity. High-Reliability Organizing offers methods to increase individual and organizational capability, the “other” way to address fear. In the early 1970s, the Fire Rescue Ambulances (RA) with the Los Angeles City Fire Department experienced increased fire ambulance-involved motor vehicle collisions. The Department’s response was to send RA drivers to the Los Angeles Police Department’s new “skid school” to learn high-performance driving. Collisions decreased. Note that the final exam was to drive two circuits on the course as one could safely. The first lap was without a siren; the second was with a siren. The driver failed if the siren speed was faster than the non-siren speed. The training officer remarked, “We don’t want you if you are driven by adrenaline.”

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Organizations do not make decisions; people do. However, organizational and national culture have solid and hidden influences on an individual’s decisions. Karl Weick’s body of work in Organization Science captures and elaborates on these influences and interactions in High-Reliability Organizing. Dempsey’s presentations revealed the numerous interactions that create a culture and the hidden ways a culture influences personal decisions. John Boyd, an influential US Air Force military tactician, captured this

in the “Orient” function in his OODA Loop method of responsive decision-making (1, 2):

Orient “shapes the way we interact with the environment... The way we *observe*, the way we *decide*, the way we *act*.” “Seen as a result, [orient] represents images, views, or impressions of the world shaped by *genetic heritage, cultural tradition, previous experiences, and unfolding circumstances*” John Boyd (3).

Just as a small group brought focus to threats in 1920s Germany, another small group can focus on capability. Rather than focusing on error and patient harm, we can redirect the focus to increasing the capabilities of individuals and organizations.

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The Environment as Noise

Rather than viewing the environment as a structural entity, for HRO, we can describe it by the flow of energy as noise. Environmental noise with constant variance per unit frequency (an equal and independent representation of all frequencies *without* autocorrelation) is ‘white noise.’ Events in white noise environments are random, without temporal correlation, because no frequency dominates (4, 5). These are relatively stable environments.

Stochastic noise, on the other hand, causes disruptions. If we separate and remove signals (cycles with predictability that have meaning) from noise (the residual variability that causes unpredictability), we can distinguish patterns of environmental stochastic noise. We can then describe the frequencies of stochastic noise inherent to the environment as colors.

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This noise can fluctuate over time or through space as serial correlations of flux (autocorrelation), or noise can exist as dominant frequencies in a power spectrum (5, 6). In the analogy with visible light, these fluctuations are termed ‘color’ to describe the pattern of predominant frequencies in a specific fluctuation range (7) [Table 1].

The various colors of noise refer to the disruptive potential of sto-

chastic energy within the environment and the characteristics of that environment. The meaning of the types of noise lies in the unpredictability of events and ‘forcing functions’ of energy, that is, the strength of the environment to force a system or population to respond.

Random fluctuations of energy, independent of time, form ‘white noise’ that follow a Gaussian distribution. Feedback within the system creates stochastic resonance and time dependence, increasing the power spectrum in the lower frequencies, called ‘red noise.’ Time dependence forms a power distribution describing a more significant influence on the system from uncommon low-frequency events. These red noise events are also poorly predictable.

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The Affective Response to Noise

Fear reactions at the subcortical level maintain a safe distance from the threat. Threat reflexes rapidly initiate protective behaviors. However, these same responses, when unmodulated, can harm the individual, distorting thinking as *situational cognitive distortions* (1). The prevalence of unmodulated stress and fear makes them appear unpreventable if not expected. This duality is the inherent vice of stress and fear. By describing their function and location in the brain, we can identify these behaviors to begin modulation for effective responses to threats.

The locus coeruleus-norepinephrine system and a modulated hypothalamic-pituitary-adrenal (HPA) axis support adequate cognition when forcing functions to exceed a person’s ability to respond. Unfortunately, when unmodulated, the amygdala and cortisol from the HPA axis can turn off an effective response. In some social systems, these unmodulated stress or fear responses become the norm, if not expected. Performance under stress then suffers, and allostatic growth cannot occur.

Stress and fear prepare the brain for adequate cognition during adversity and drive safe and effective behavioral engagement. Not recognizing these functions shifts the research and conversation to the damage caused by unmodulated stress and fear. The *function* stress and fear cause damage. This is the inherent vice of stress (9). Karl Weick described how failure from *not* acting is invisible and becomes organizational knowledge (10). *Not acting* reduces the individual stress experiences in the ecology of fear. When the inherent vices from stress and fear lead to not acting, then the behaviors to avoid threats become the organizational knowledge Weick describes.

Thought in a Noisy Environment

The locus coeruleus-norepinephrine (LC-NE) system is how we think under stress. It is the source of adaptive thinking and behaviors, initiating the adaptive cognitive shift necessary for survival (11). NE can silence some signals while enhancing others. The LC has an increased response to strong stimuli with decreased response to weak stimuli, enhancing the signal-to-noise ratio. The brain can encode and filter salience (12).

It is not happenstance that we contrast conformity and obedience with creativity and initiative. These are opposing sets of cultural values (13). In a white-noise environment, conformity and obedience are sufficient. We need all four in red noise environments, particularly with the abrupt pink noise event.

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Noted in the acknowledgments are individuals who moved from white noise conformity to red noise initiative within months to weeks. They naturally adopted the methods for the red noise environment by observing their success in others, not through education, training, or consulting.

White Noise Stability

‘White noise’ is environmental noise with constant variance per unit frequency. That is, there is an equal and independent representation of energy over all frequencies *without* autocorrelation (feedback). Events in white noise environments are purely random, without temporal correlation, because there is no predominant energy frequency (4, 5).

The variances from data in a white noise environment have characteristics distinguishing them from red or pink noise:

- They form a Gaussian distribution amenable to statistical analysis and calculated probabilities. Environmental elements are fully independent.
- Variance decreases over time or with increasing data.
- Frequencies are uncorrelated in time and have an equal distribution of energy.

The predictability of white noise environments influences the normative stance (14) and is the ideal scientific environment. For example, there is no energy exchange with the external environment, while elements’ independence and randomness support the statistical analysis and probability predictions.

Table 1. Patterns and Characteristics of Noise (8)

Color	Structure	Variance	Distribution
White	No frequencies dominate Flattened spectrum Spectral density has equal amounts of all frequencies	Data <i>decreases</i> variance Forms Gaussian curve	Gaussian distribution - Elements fully independent - No autocorrelation
Red	Low frequencies dominate Long-period cycles	Data <i>increases</i> variance Forms power distribution	Power law distribution - Elements <i>not</i> independent - Mutual/ reciprocal relations
Pink	The midpoint of red noise The slope is precisely midway between white and brown (random) noise.	Data <i>continuously increases</i> variance. Distinguishes pink noise from reddened spectra	Power law distribution - No well-defined long-term mean - No well-defined value at a single point

Stability

When energy enters the system, white noise can cancel the intruding energies like noise-canceling earphones work. This process gives stability but may also produce a false sense of capability that the organization can respond to the unexpected.

Reddened long-period fluctuations or infrequent pink abrupt changes can also give the appearance of a stable environment if not a stable world. The efforts of those familiar with High-Reliability Operations or who recognize the inevitability of a forcing function or abrupt change can maintain system stability despite disruptions or minor forcing functions. This context gives rise to the trope “Armies prepare to fight their last war, rather than their next war.” Viewing wars as pink noise events or reddened noise-forcing functions, we can recognize that the years between wars are not white noise periods of peace. Instead, they are periods of attention to forcing functions and preparation for abrupt change.

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The decreased environmental pressure of white noise environments favors the generalization of a population over periods that extend longer than the life of individuals. System change occurs over generations in an evolutionary manner rather than by context-dependent ecological processes (15). Leadership is less critical than executive, administrative, and managerial skills (16), where ‘categorical work’ creates classifications and rules to work by (17) [see below].

The organization also loses specialization as the leadership becomes more centrally located. New members who join the organization or scientific discipline will experience new, reset baselines (18) with new generalized norms and normative values. There is a loss of practical wisdom as new abstract beliefs become privi-

leged. Beliefs change, and the culture follows.

The stability of a white noise environment permits context-free concepts, theories, and problem-solving. Classifications (17) and abstractions (19) gain significance. Experts develop mastery over distinct bodies of knowledge. Rather than *experiential* empiricism, theories, beliefs, and *experimental* empiricism become privileged.

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Affect from White Noise

White noise variance and measured error are also measures of novelty, uncertainty, and uncontrollability, which are the determinants of human stress reactions. The response to these stressors is to “disarm” the *executive functions*, enabling survival behaviors. The hypothalamic-pituitary-adrenal (HPA) axis releases cortisol to constrain the executive functions integrated from opposite ends of the brain: perception, hastily created plans and motor activity. This is the positive aspect of stress or eustress.

These cognitive stress reactions serve the function of enhancing cognitive performance. Cortisol inhibits memory recall in select memory systems while enhancing habit memory and learned behaviors. Cortisol also selects memory formation and transforms threat reflexes into learned behaviors. The stress response *functionally* inhibits executive functions.

Thought in White Noise

Operations in a white noise environment occur independently of the environment. Theories and beliefs are readily incorporated into operations. There is a minimal gap between theory and practice or between belief and the environment.

Concepts provide the necessary elements for comparison, standardization, and quantification. This use of concepts has become a foundation of modern science (20). The Linnaean system categorizes typologies into taxonomic hierarchies to show relationships. ICD-10 codes create discrete categories out of continuous public health data analysis processes. The categories of evidence-based medicine are intended to reduce waste and medical complications.

The idea of concepts entered scientific thought from Immanuel Kant's (1724–1804) original scientific, philosophical work. He posited that knowledge is accessible and that knowing the world and its phenomena is possible because all elements can be contained within known concepts, with a fundamental principle being causation. His influence spans the 18th Century to today in the physical sciences, the life sciences, modern mathematics, mathematical logic (21), and social sciences (22). We use “spatio-temporal re-

lations” from his idea of space and time as entities that structure experience, distinct from objects themselves. The formulation of “social knowledge” is how Kant mediated between the facts and thoughts of reason and the values and actions of morality (22). *Kant's Critique of Pure Reason* (23) is one of the most influential works in philosophy. Kant's influence on the definitions of knowledge and the validity of science directly influences how we experience science.

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In a more predictable environment, homeostasis becomes the goal, the return to the previous state. Resilience describes recovery. A stable environment reduces demands on less experienced personnel who need less supervision compared to the variability of a reddened environment (4). In these environments, we see greater reliance on protocols and algorithms.

Information

For Claude Shannon [1948], choosing between signals and choosing from randomness creates information. Certainty has only one signal to choose. Because having only one possibility is not informative, certainty is not information. Communication is the act of resolving this uncertainty, even as information entropy causes communication to corrupt information.

In the white noise environment, information is similar to Immanuel Kant's idea of concepts – all concepts exist. Because there are no disruptions, information exists, is stable, and is accessible. The Gaussian distribution is information-dependent. Therefore, collecting more information decreases variance. This method makes it easier to treat problems as a puzzle (24). After we collect the puzzle pieces, we have the answer – a form of deductive reasoning.

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Information is also discrete, excluding intermediate values. The information does not contradict other information in the same context. The information does not change. Classical logic serves well

in the context of a white-noise environment.

However, this has a significant influence on arguments. If information cannot contradict other information, and there is no gradation of information, then we can disprove someone’s idea by focusing on contradictions and inconsistencies. To disprove one point disproves all. We encounter these individuals as the ones focused on normative values and distracting minutiae.

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Precision, Accuracy, and Error

Data in white noise environments form a Gaussian distribution. Collecting more data narrows variance, making white noise systems *information dependent*. Therefore, it is reasonable for those in business management to be “data-driven.” Increased data can also reveal the presence of distinct populations, such as in a bimodal distribution or a distribution with ‘fat tails.’

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Precision is a measure of reduced variance in a Gaussian distribution. The Gaussian distribution can produce normative values capable of error measurement. Defining error as the distance from the desired or expected (normative) value allows us to use error as a measure of precision. Because white noise systems are information-dependent, collecting more data reduces variance and gives more meaning to error measurements. In systems that require or value reductions in variance, such as tightly coupled systems, error as a measure of precision becomes helpful to ensure the smooth functioning of hardware and white noise operations.

We must measure precision as the *distance from* the desired state *before* operations because we cannot change precision *during* operations. Measures of precision errors during the disruption of operations are not valid due to the fluctuating red noise energy frequencies.

Error as the distance from the expected is *one* type of error. Increasing precision to adjust our tools or performance in real-time is not practical. Identification of this type of error allows corrections in training, performance, and production processes *before* use in operations.

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Data from red or pink environments do not form a Gaussian curve. Instead, operators in these environments focus on *proximity to* the desired value or state. This modus makes sense because fluctuating energy frequencies will change the environment, possibly leading to a change of objective. We can use proximity to the desired state to adjust our performance through feedback, increasing our accuracy in real-time. As described above, this is not an option available for precision.

Precision is a single helpful measurement to improve the program, but not in real-time. Accuracy is not a single measurement but a series of measurements generated from feedback. Such a series of measurements improves accuracy in real-time. Accuracy is vital for moving targets [Table 2].

Error in the white noise environment comes from acting and is visible and correctable. The stability of the environment conceals ‘error from not acting,’ enabling such errors to become incorporated into organizational knowledge (10).

Table 2: Precision versus Accuracy (25)

Precision	Accuracy
Hardware	Human behavior
Assures our understanding	Extends our understanding
Applicable to white noise Gaussian distribution (“Six Sigma”)	Applicable for red and pink noise Power distribution
Error identifies structural defect.	Error generates information An error ensures safety by identifying boundaries of knowledge and performance.
Identified by feedback Short feedback only Long feedback contains too many factors	Improved by feedback Incorporates long, delayed, indirect feedback loops
Supports certitude, motivated reasoning, the hedgehog, and narcissism	Creates doubt, the fox, and psychological grounding

Table developed with Ian van Stralen.

Decision making

A convergent, deductive, analytic approach makes sense in white-noise environments. We search for facts and information because they guarantee our deductive hypothesis. The structures we create, and our actions reinforce acceptance of the normative frame and the security they offer.

This linearity and stability, however, impede generating the stochastic resonance that brings stability to dynamic environments (26). Rigid structure and linearity will narrow and increasingly constrain our responses.

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Decision trees identify alternatives and guide decision-making when the necessary information is unavailable (27, 28). They were first introduced for capital investment and then later applied to healthcare.

Classical logic is central to decision-making in the white noise environment. We stress two well-known laws of classical logic because they may improperly be applied to red or pink noise environments. Some logic can incorporate multiple values, allow contradiction, and include ‘indeterminate’ truth values.

- *The law of excluded middle* – every proposition is either true or false. There is no gradation.
- *The law of noncontradiction* – the same proposition cannot simultaneously be true and false.

Solving

‘White noise’ has the same variance for all frequencies. No temporal or correlation variance exists, and time and space have constant variance (7, 29). The values of a random signal at two instants in time are entirely independent. The Gaussian distribution of white noise environments supports discrete concepts, hierarchical systems, and linear thinking independent of context or the environment. The observer’s frame of reference moves outside the flow of events and becomes fixed as Eulerian specificities (30).

Classifications act as objects for cooperation and create boundary objects for communication across infrastructure during a disaster (31, 32). Classifications build from data, which is not a problem in the Gaussian white noise environment where more data narrows the variance to form a norm. Data increases variance in a red-dened environment, and we lose the norm. One solution is disregarding environmental noise (5), but the noise *is* the crisis.

Classification and standardization can solve the problem of infor-

mation correlation in a white-noise environment. Precision supports distinct classifications, while standardization gives meaning to precision. Precision is reliable in white noise systems as we see repeated or similar actions which produce predictable results. That reliance on precision, such as ICD-10 or DSM codes, leads to loss of information while classifying a situation.

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The white noise environment contains Herbert Simon’s well-structured problem that is amenable to the algorithm (33, 34), solved much like a puzzle with a set number of pieces fitting into a pattern (24). Abstractions and concepts provide the basis for understanding and prediction. With the Gaussian distribution, problems tend to be information-dependent, and error measures the distance from the model or concept. Classical logic and scientific reasoning are used (35).

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Problems

When we separate the organization from the environment, as when accepting the white noise environment, we sacrifice accuracy for conceptual tractability. Classification and standardization can solve the problem of information correlation in a white-noise environment. The problem arises from who sets the standards. Making sense in one context does not necessarily make sense in another, even between a physician and nurse standing by the same neonate. “One person’s standard is another’s confusion and mess,” Leigh Star (36).

Leaders can effectively develop a structured, rule-driven system within white noise stability. All significant thinking occurs in the central part of the organization. Over time, the flow of information diminishes as the periphery becomes marginalized and the central part comes to the protection of its status (37).

The belief develops that the organization is best protected by conforming to standards, obeying rules, and vigilance for error. Discussion of legal matters, compliance, and liability precede increasing capabilities and resources. Repeated discussions of harm and error create the ecology of fear. Repeated discussions

of threat, rather than the capabilities to engage the threat, create self-regulating behaviors that impair initiative and engagement. The lack of variance supports the idea of the effectiveness of fear over capability as a leadership method. Some people think differently, they do not fit in, and they are not “on the bus.”

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Two physicians addressed this when creating a PICU with ward and NICU nurses and respiratory care practitioners. One was a former US Navy Aviator and Vietnam veteran, and the other (DvS) was a former fire rescue ambulance paramedic. To ensure that all PICU staff could approach one of the intensivists, they made a list of staff members they found challenging to work with. They divided the list into two sets, each taking one list. The intensivist would then focus on the people on their list to keep active contact with the person. From their experience, they did not want anyone to feel isolated. Fifteen years later, one of the physicians (DvS) was assigned “leadership coaching.” The leadership consultants found the author “too approachable during this training.” Staff should not walk up to an attending physician and ask about patients. The hierarchy and chain of command in healthcare have remained.

In the white noise environment, we are challenged and begin to gain a sense of mastery. We begin to see the formation of certitude, the development of self-image that can surpass the environment, and conceptual mastery develop into motivated reasoning.

In the white noise environment, mastery can occur without experience – but not understanding.

Red Noise Forcing Functions

Cognition for the white noise environment is relatively straightforward. Minimal fluctuation in the environment permits precision and procedure that reduces error, identifies specific situations to guide decision-making, and supports information gathering to improve problem-solving. A top-down or ‘whole-field view’ develops when spectators accept this.

It is the act of accepting the white noise environment as normative that privileges the Gaussian distribution, statistics, and probability functions. Knowledge becomes filtered through evidence-based approaches developed in a well-controlled environment. Knowledge from *experiential* empiricism, knowledge by acquaintance, is diminished in favor of knowledge from *experimental* empiricism, that is, knowledge by description.

A white noise environment is a decontextualized environment. Human behavior is feedback from the environment processed through knowledge and experience. That is, human behavior is autocorrelated – red noise.

Forcing Functions

The organization is orderly. The organization is not ready for environmental ‘forcing functions.’ Forcing functions are the strength the environment has to force a system or population to respond. “External forcing by environmental noise alters the qualitative nature of the dynamics” (7). The environmental noise is red noise which will interact with the red noise of human behavior, which has its forcing function.

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One behavioral forcing function derived from a white noise environment is the belief in the “zero-sum game.” Resources and energy do not enter or leave these environments. We can see how some individuals believe that resources are limited: if one wins, another must lose. This belief drives behaviors that endanger the organization. These behaviors are too readily described as prudent, ethical, or principled.

Forcing functions are a hallmark of the red noise environment. Stochastic processes with slow fluctuations or low frequencies (lengthy periods) have a ‘red’ spectrum. Low-frequency events are rare and have a greater spectral density. Low-frequency, rare events have a more significant influence on the system than more common, high-frequency events with less spectral density (5). Their influence comes from spectral density.

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The variances from data for the different types of noise produce different probability distributions. Red noise contains low frequencies with energy. Environmental elements are *not* independent; the organization operates within the external, open-system environment. Variance *increases* over time or with increasing data to form a power distribution. There are rapid fluctuations.

We now see risks from decontextualizing knowledge by acquaintance and experiential empiricism. While top-down specifications produce a broader, ‘whole-field view, we overlook the bottom-up

specifications of operations, tactics, human readiness, and experience. These are the qualitative characteristics that emerge from the activities of 'local groupings' (Table 3). The methods used to increase human and system capabilities are overlooked. The contextualization of experience counterintuitively supports translating experience and capabilities into new and different contexts.

Table 3: Specifications of the Whole-Field View and Local Groupings (38)

Whole-field view	Local groupings
Eulerian, quantitative	Lagrangian, qualitative
Decontextualized	Contextual
External, fixed point	Within flow
Select a viewing point	Select a starting point
Focus on the specific location	Focus on an individual moving parcel
Flow	Trajectory
Multiple fixed positions	Continuous measure with position and pressure
Rate of change of system	Individual parcels

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The whole-field view is necessary. What is dangerous is the spectator or observer who moves the frame of reference outside the flow of events. This construct is when the frame becomes fixed as Eulerian specificities (30). Authorities use this external reference frame to create models for the reddened environment, yet the reddening of the environment increases variance, dissolving Gaussian distributions and creating unpredictability (5).

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Time Variance, Uncertainty, and Chaos

Time-variance describes a system with output characteristics that are explicitly dependent on time. In time-variant systems, specific parameters or influences change with time. The system responds differently to the same input, depending on when it occurs. Linear time-variant systems are linear because they follow an equation, and time-variant because variability over time (time is a variable)

creates an oscillation.

The time variable gives this “sinusoidal cycling” an associated uncertainty principle: what we measure will change with time. When a wave equation determines a particle’s momentum, we know where it is along the wave form. Heisenberg’s Uncertainty Principle says that to know the particle’s position, we must stop it, but it has no velocity. In a time-invariant system, the output is not a direct function of time. Increasingly precise measurement of one decreases the precision of the other.

Deterministic chaos develops when the oscillation continues, and the ‘output becomes the new input’ in the same deterministic equation. This iterative process is the logistic equation, like the equation for a parabola, but using the output for the following input. The constant, r , is the rate of reaction for the system. As r increases, the system passes through a series of stable equilibria. At r greater than three, the results become random and sensitive to initial conditions, *deterministic chaos* (39). “Deterministic” as it is determined by the logistic equation and “chaos” because the unpredictable outcomes are sensitive to initial conditions” (8, 39). While matter, energy, and probabilities are conserved, information and entropy are not conserved (40).

Self-organization promotes stability and stable patterns. Self-organizing systems can abruptly transition from one pattern to another, even with a slight change in the system, termed a *bifurcation*. Transitions in the logistic equation can be dramatic and related to a single parameter – such as r . (39, 41).

Emergence

Local, non-linear interactions are the basis of self-organization. Missed in this organizing principle is the emergence of novel properties. These properties put to the test the capabilities of individuals and the organization. Moreover, it will ruin the best plans.

Affect in Red Noise

Forcing functions have a greater effect on the brain than the disruptions that develop within white noise environments. We begin to experience stress-impaired cognition and fear-circuit behaviors – all responses mediated by neurochemicals. They can come on with incredible speed and, when accepted as simple neurochemical effects, can be interrupted almost as quickly.

Stress

Novelty, uncertainty, and uncontrollability, the domains of the executive functions, initiate the release of cortisol. Cortisol blocks memory retrieval in the prefrontal cortex and hippocampus (memory center), and the amygdala directly inhibits the prefrontal cortex. Under stress, the brain “disarms” the executive functions to prevent the intrusion of abstractions and future thinking while limiting various memory systems. Even minor stress will impair executive functions (42).

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The Executive Functions

Appreciating the executive functions helps understand the function of the stress response. The executive functions support motor attention, working memory, and inhibitory control:

- *Motor attention* prepares for impending motor action – “memory of the future” (43).
- *Working (short-term) memory* allows changing sensory stimuli to mediate perception and action toward a goal in real-time (43). As we work, we can ‘delete’ these memories as soon as we no longer need them.
- *Inhibitory control* and selective attention protect goal-directed behavior from interference, distracting information, and impulsive or reflexive behaviors (43); inhibit emotional memories (44, 45), well-established habits, and more easily processed intuitions (46).

“Working memory allows you to remember events of the last several seconds or minutes and to prepare and plan “forward” in time for prospective, near-future motor acts. Working memory has the attribute of rapidly ‘forgetting’ information as motor actions evolve. During the action, we must release memories as we continually bring new things into memory.”

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Cognitive flexibility refers to the ability to shift between cognitive rules or modes of thought (48). Unrestrained neurological stress responses release almost pure bottom-up control to produce self-preserving behaviors. Cortisol and the amygdala continue suppressing executive functions, and a defense cascade follows (49).

Stress-Impaired Cognition

Uncontrollable stress releases cortisol to produce *stress responses*, generally related to failed memory recall. The primary memory systems affected are declarative memory for what is learned, episodic memory of experiences, and working memory for active problem-solving. Retained is procedural, or habit, memory, allowing the person to continue acting with practiced behaviors without losing time thinking and developing plans or actions.

This is “distress.” For those using the Yerkes-Dodson Curve (50), this inflection is when stress impairs performance. For those with experience in dangerous contexts, impaired performance reveals poor training and leadership.

Forcing functions increase the valence of novelty, uncertainty, and

uncontrollability.

- *Novelty* is processed in the right cerebral cortex, while the left cerebral cortex processes familiar perceptions. With increasing novelty, it becomes more difficult to identify something familiar or identify an analogy that brings understanding.
- *Uncertainty* and ambiguity in decision-making occur in the ventromedial prefrontal cortex (vmPFC). The vmPFC is also involved with making decisions in uncertainty (50). See below. Acting to change an element of uncertainty readily supports creating Shannon Information in a white noise environment.
- *Uncontrollability* or unpredictability is the stimulus for the HPA axis.
 - Uncontrollability is the most significant stressor because finding controllability is the primary objective during any crisis, and uncontrollability is the greatest threat to humans.
 - *Motor cognition* describes how we adjust our actions to changing situations and learn through physical actions. The operator learns what works through action; experienced operators think best while acting (20, 51). Karl Weick captured this in his “recipe” for sensemaking, “How can I know what I think until I see what I say?” (52).

“However, the field is more extensive, and circumstances are in flux amidst a red noise-forcing function. Beliefs must be revised and updated through doxastic operators, one of the modal logics. Modal logic can incorporate multiple values.”

However, the field is more extensive, and circumstances are in flux amidst a red noise-forcing function. Beliefs must be revised and updated through doxastic operators, one of the modal logics. Modal logic can incorporate multiple values. Rather than value as a function, values can operate as relations. The proposition relates to true, false, or neither (53).

Doxastic logic (Greek *doxa*, “belief”), a form of epistemic logic, concerns the logic of participants’ beliefs. Doxastic logic provides reasons for belief rather than knowledge. The difference is that a belief is probably not necessarily true.

- A *belief update* refers to accounting for a change in the situation and acquiring new, more reliable information; this requires us to change our inaccurate old beliefs to more accurate, new ones.
- *Belief revision* occurs when we identify the old information as less reliable and use new, more reliable information to revise our older beliefs; we keep the new belief as close as possible to the old belief while accepting the newer, more accurate information.

Operators in dangerous contexts use concrete nouns for description and emphasize action verbs for communication. Recent neuroscience findings support this behavior. Action words and mo-

tor action, noted above, share common cortical representations. Action verbs, more so than concrete nouns, affect overt motor performance dependent on timing. An action verb will interfere with a reaching movement in progress within 200 msec. The exact words processed *before* movement will *assist* the movement (54). This action, fortunately, is category specific. A quick shout to move a hand causes hands to move, not random body parts. The category-specific, functional linking of language and motor action in the left hemispheric cortical systems link arm and leg actions with processing specific kinds of words. The two systems interact to produce meaningful information about language and action (55-57).

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Fear-Circuit Behaviors

For practicality, we consider fear-circuit behaviors as safety behaviors that respond to approaching threats, then maintain a safety distance. The initial fear reaction is cortical. With increasing proximity to the threat, fear migrates to the midbrain.

An impending threat initiates fear circuitry behaviors below the level of awareness. Upon reaching awareness, the individual can augment or accelerate fear behaviors. Fear behaviors maintain a ‘flight distance’ from the threat, creating a safe distance (‘fear flight’), or they create a safe distance should the threat breach the ‘defense distance.’ The individual will attack for self-defense and escape (‘fear fight’) (58).

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A distant threat within the “flight distance,” whether temporal or spatial, increases the ventromedial prefrontal cortex (vmPFC) activity. This region is vital for decision-making in uncertain, risky, ambiguous, or context-dependent conditions. The vmPFC uses conceptual information about specific outcomes to shape affective

responses, such as determining the most adaptive response given the particular situation (59). The vmPFC connects to the amygdala to determine the motivational importance or degree of the threat (50). The amygdala connects onward to the bed nucleus of the stria terminalis (BNST) to control a repertoire of behavioral defensive states (60, 61).

“The additional proximal threat will switch activity from the vmPFC to the phylogenetically older midbrain periaqueductal gray (PAG) nucleus. The PAG identifies an approaching or receding threat to functionally switch the repertoire of behaviors to fast reflexive behaviors (e.g., fight, flight, or freeze) (60, 62, 63).”

The additional proximal threat will switch activity from the vmPFC to the phylogenetically older midbrain periaqueductal gray (PAG) nucleus. The PAG identifies an approaching or receding threat to functionally switch the repertoire of behaviors to fast reflexive behaviors (e.g., fight, flight, or freeze) (60, 62, 63). This continuous switching within the PAG is a blend of the bottom-up responses to threats before they come to our awareness and top-down cortical neuromodulation from the vmPFC and the anterior cingulate cortex.

Problems

Cognitive behaviors directed toward self-protection are organized into offensive and defensive actions. *Offensive protections*, generally initiated to protect others, include prompt attacks, surprise, concentrated actions, fast tempo, and audacity to stop the spread of the problem. This aggressive force projection secures the initiative but is pathological when directed toward people. The aggressor uses blame, accusation, and personal attacks.

Defensive protections, generally initiated to protect self or close associates, come about when demands clearly, though subjectively, exceed a person’s capabilities, performance, security, or ability to survive. Ad hoc emergency plans will focus on personal survival or the person’s sense of safety. The person may withdraw or move to a place of psychological or physical safety (64) – not going near the source of the threat, which could be the leader, an administrator, or a colleague. Whether a leader, administrator, or line worker, the individual keeps a safe distance from the situation, which impairs their ability to identify correlations or causations. As a result, rationalizations, analogies, clichés, metaphors, and abstractions support reasoning, plans, and actions. The person will deflect, excuse, justify, or use prophylactic self-blame. This individual is less helpful in protecting others because of the primary focus on reducing risk to themselves.

Fear fight-or-flight. The proximity of the threat drives fear-flight. *Fear-fight* develops during the fear process to enable escape (58). Because humans can separate the motor and affective components of emotion, the motor component of fear-flight can appear as physically leaving. Fear-fight, the self-defense fight, is a fight to escape and more likely consists of pushing, shoving, and poorly aimed punches. For the affective component, the person appears to avoid, ignore, or distract, perhaps by asking for more information (65). Verbal maneuvers include denial of a problem, dismissiveness of the individual’s concerns, or depreciation of discon-

firming information. Statements such as “Why wasn’t I informed” or “The problem is that you complained wrong” are common. Fear-fight for self-defense starts within the defensive distance to help the individual escape.

“Because proximity drives fear, the individual with extreme unmodulated fear has a narrow perceptual focus toward the threat and operates with severely concrete thinking. Concomitant stress from uncertainty and feelings of uncontrollability (hopelessness) generates a cortisol HPA response taking the prefrontal cortex ‘off-line,’ impairing cognition.”

Because proximity drives fear, the individual with extreme unmodulated fear has a narrow perceptual focus toward the threat and operates with severely concrete thinking. Concomitant stress from uncertainty and feelings of uncontrollability (hopelessness) generates a cortisol HPA response taking the prefrontal cortex ‘off-line,’ impairing cognition. The reasoning is not practical. Physically, rather than running from the threat, the person escapes directly toward a safe place. There is no time horizon. Fear-fight is focused on escape from the threat, then running in a straight path to a safe place. Once in safety, the affective and motor components are likely to cease.

Stress-induced Cognitive Disorders

Stress impairs abstract thought and working memory. This impairment affects the ability to regulate thought, behavior, emotion, and flexibility of attention:

- Choke (expectations being observed).
- Impaired memory recall/enhanced procedural memory.
- Loss of abstract thought when prefrontal cortex and executive functions are impaired.
- Concrete thinking and reasoning due to loss of abstract abilities (amygdala impairs cortex).
- Rules are abstractions, therefore, challenging to recall and use.
- Failure of cognitive strategies: “*Even quite mild acute uncontrollable stress can cause a rapid and dramatic loss of prefrontal cognitive abilities*” (42).

Thought in Red Noise

The focus on stress, eustress, and distress distracts from the brain systems for thinking under stress: the locus coeruleus-norepinephrine (LC-NE) system. The amygdala responds to the perceived threat by causing the periventricular nucleus of the hypothalamus to secrete corticotropin-releasing factor (CRF). CRF simultaneously stimulates two systems: 1) the hypothalamic-pituitary-adrenal axis (HPA) to inhibit abstract thinking and memory and 2) the locus coeruleus-norepinephrine (LC-NE) system for adaptive thinking and behaviors. This initiates the adaptive cognitive shift necessary for survival (11).

From a thorough review of the literature, Jennifer Ross and Elisabeth Van Bockstaele (12) have identified the two themes of attention and arousal. More critical is their finding that LC-NE mediates selective attention for salient stimuli with concurrent silencing of irrelevant stimuli. That is, during a challenge from threat, both excitation and inhibition coincide throughout the brain.

While combined excitation and inhibition seem straightforward, the method used in the models effectively engages threats. NE can silence some signals while enhancing others. The LC has increased response to solid stimuli with decreased response to weak stimuli, enhancing the signal-to-noise ratio. The brain can encode and filter salience (12).

Inhibitory control, or response inhibition, is the executive function that inhibits impulses and dominant, pre-planned (prepotent) behavioral responses to stimuli. This executive function helps select behaviors consistent with one’s goals (66).

“The focus on the effects of stress on attention leads to the idea that active attention processes information from the top down. The individual directs attention to attaining a goal. Passive attention processes information from the bottom-up, driven by environmental stimuli.”

The focus on the effects of stress on attention leads to the idea that active attention processes information from the top down. The individual directs attention to attaining a goal. Passive attention processes information from the bottom-up, driven by environmental stimuli. Attention is intentionally focused (top-down), or attention is attracted (bottom-up) (12). Humans may innately and subcortically evaluate the environment before environmental cues reach awareness, trigger emotions, or initiate higher-order cognition (67).

Saliency. As stress research increased, the threat became the focus of the stimulus that caused stress. A threat can compromise survival. Suppressing threats would involve any number of tasks. Specifically, it would involve selecting specific tasks at the opportune time. Ross and Van Bockstaele (12) posit that task prioritization to meet the threat led to the consideration of salience as a cognitive process.

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Dorsal and Ventral Attention Networks

Two neuroanatomically defined systems appear to control the top-down and bottom-up information processing during the orienting reflex. Environmental cues from novel or infrequent events interrupt ongoing task-related cognitive activities. This bottom-up pro-

cessing of sensory cues quickly reorients cognitive attention (68).

- Dorsal Attention Network (DAN), top-down cognitive information processing, task-related stimulus-response, pairs cognitive cues with motor responses
- Ventral Attention Network (VAN), bottom-up identification of salient or novel stimuli in the environment

DAN, left-lateralized in the prefrontal cortex, may control attention involved in motor responses to task-related stimuli. The right-lateralized VAN may facilitate reorientation when encountering a novel or infrequent sensory stimulus. When VAN detects unexpected or novel stimuli, it interrupts DAN to reorient from the current activity to a new behavioral response. This VAN activity depends on nor-epinephrine delivered from the locus coeruleus (69).

The Triple Network

Brain regions do not respond to stress in isolation. Organized, functional, dynamic networks interact across brain regions (70).

- *The salience network (SN)* responds to salient stimuli, orienting and coordinating attention toward internal or external information. SN may support hypervigilance.
- *The default mode network (DMN)* is activated during stimulus-independent tasks or internal thought, forming perceptions of others, or retrieving memories, usually suppressed during CEN activation.
- *The central executive network (CEN)* supports higher-order cognitive tasks, attention, manipulating information, working memory, and decision-making for goal-directed behavior.

“The science has not settled, causing inconsistent naming and regionalization. However, the SN (salience) appears to be the highest in the hierarchy. The Attention and Triple Networks interact, suggesting that cognition under stress balances three core ICNs: DMN, CEN, and S.N.”

Combined Networks

The science has not settled, causing inconsistent naming and regionalization. However, the SN (salience) appears to be the highest in the hierarchy. The Attention and Triple Networks interact, suggesting that cognition under stress balances three core ICNs: DMN, CEN, and S.N. From their coordination emerges cognition, goal-directed, and stimulus-directed behavior (12).

- Connections from SN (salience) and DAN (information processing) to DMN (stimulus-independent) are inhibitory, while reverse connections are weakly excitatory.
- Bidirectional connections between SN (salience) and DAN (information processing) are excitatory.
- VAN (environmental reorienting) has shared regions with SN (salience).

Information

This problem of more data clouding the conclusions develops when an event is influenced by what preceded the event. That is, the event is no longer independent of preceding events. Auto-

correlation is when past observations or events have an impact on current ones. Autocorrelated events are more susceptible to feedback loops, allowing even minor or mundane noise signals to achieve resonance, becoming amplified and consequential.

In the red noise environment, information has the behavior of Shannon's Information Entropy (71). Disruptions from forcing functions change information as well as the character of information. More data increases the variance of the Gaussian curve. Data in the red noise environment create a power distribution with greater spectral density in the less frequent spectral ranges, a behavior similar to red light spectra.

With information being less reliable, we approach the environment as a mystery (24). We are unaware of the information until we use it, a form of inductive reasoning. We may not know the answer until after the resolution of the event, and at that point, another forcing function may arrive.

“Ambiguity develops when we add the element of time – the addition of a past creates multiple ways the situation developed; the addition of a future creates multiple possible developments; the addition of only one intervention, added to the complexity of the situation, creates multiple possible responses.”

Ambiguity is, to some degree, uncertainty with a time dimension. Ambiguity develops when we add the element of time – the addition of a past creates multiple ways the situation developed; the addition of a future creates multiple possible developments; the addition of only one intervention, added to the complexity of the situation, creates multiple possible responses. More information does not resolve ambiguity, as the relevance of information may change with a different past or future. Because of the many choices, the unexpected event has high information entropy. We gain information by making choices when we engage in the unexpected (72).

The give and take of interacting systems, increasing feedback, rapid oscillating processes, the frequency of the forcing functions, and the loss of the Gaussian distributions disintegrate the utility of inferences from classical logic. Events of lesser time scales and smaller magnitudes do the same. We will experience contradictions and the need to infer across quantitative and qualitative data collected from heterogeneous systems in many states.

Paraconsistent and paracomplete logics meet the needs for rapidly changing, conflicting information and adjusting solutions.

“Handling contradictory data is one of the most complex and important problems in reasoning under uncertainty” (73). Paraconsistent logic allows contradiction without allowing any solution, thus treating inconsistencies as informative. Paracomplete logic allows us to work with entities undergoing continuous change. There is no need to assume “A” or “not-A.” Nonmonotonic logic allows us to change our solutions as events evolve.

Precision, Accuracy, and Error

Structures exposed to entropic dissipating energy must remain within a specified range for continued operations. The system fluctuates in response to these environmental forcing functions,

with variance increasing concerning the power of the forcing functions. Feedback within and between the forcing function and the system forms a power distribution. More data increases variance making prediction difficult. Measurements that differ from expected or desired values may indicate changing circumstances, the limits of knowledge, or the boundary of performance. Error, wrongly considered a failure signal (74), has value in the HRO. Though red and pink noise environments are *information insensitive*, they are not feedback insensitive. Engagement generates information through real-time feedback despite rapid changes in human performance or the environment.

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Accuracy measures increasing proximity to the desired or expected target [Table 2, above]. Reciprocal feedback uses errors for real-time correction. This correction is the artillery mantra, “Ready! Fire! Aim!” Accuracy is valuable when engaging uncertainty; it is necessary for ambiguity and a moving target. Accuracy from reciprocal feedback is a basic form of engagement.

“Accuracy is a protective process for a reddened noise environment. Accuracy can correct the model or information during the operation when relying on a new model or imperfect information. In dangerous contexts, inaccurate information and models can kill (75).”

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Problem-Solving

Loosely coupled, overlapping, and gapping concepts create a confusing environment where the problems are ill-defined (14). Herbert Simon (33) described how we naturally use heuristics to solve these ill-structured problems. Heuristics, however, create a bias (76) that can be corrected by error (74) and motor cognition (77) – ‘error by acting’ is visible and correctable (10). In a dynamic environment, the ill-structured problem is more of a mystery we solve by finding clues (24).

Doubt as a problem-solving method, combined with rigorous evaluations of failure, breeds super forecasting ‘foxes’ who know a

little about a lot, a strategy that further drives learning and develops a different type of mastery (78). Doubt, broad knowledge, and concern for consequences are characteristics of practical common sense problem solving (79). Leadership is an integral part of executive, administrative, and managerial skills (80), bringing together categorical work with ‘articulation work,’ the way things worked out in practice (17).

“Leadership is an integral part of executive, administrative, and managerial skills (80), bringing together categorical work with ‘articulation work,’ the way things worked out in practice (17).”

The long periods without change mimic a white noise environment. Individuals who enter a red-noise environment during such a period may believe they are operating in a stable environment, much like a shifting baseline (18) [see below]. The result is tolerance of ‘hedgohg forecasting’ but with greater value in ‘fox super forecasting.’

Situational Cognitive Distortions

It is often the situation that distorts our cognition. We do not live in a constant state of stress, fear, or amygdala-driven behaviors. Maladaptive stress and fear behaviors become normalized when we do not recognize how the situation distorts our thinking. We call these *situational cognitive distortions* because, absent stress or fear, the individual operates at a high level of cognition (1, 65, 81).

- Stress – cognitive impairment
- Fear – the creation of distance, drive to a safe place
- Amygdala – existential protection

Situational cognitive distortions can develop from intrinsic sources, such as a supervisor pressuring somebody mentally, causing the impaired recall of information. This freeze response is typical in the medical education method of “pimping,” to ask questions that demonstrate a person does not know. It is like choking in sports. This quickly develops into innate responses of subordinates to the supervisor’s presence while reinforcing the supervisor’s belief in the poor performance of the individual.

Common cognitive distortions include (82, 83):

- Anger
- Frustration
- Avoidance
 - Complete or avoid tasks
 - Focus on inconsequential tasks
 - Addressing easily accomplished tasks first
- Distractive comments
 - Responding to distractions
- Freeze (“attentive freeze”)
- Actual cognitive or physical freezing
- Nausea and avoidance
 - Urge to urinate or defecate

- Confusion
- Mental freeze
 - Inability to solve simple problems
 - Failure to recall knowledge
 - Impaired working memory

From our experiences and discussions with veterans from dangerous contexts, we have identified three salient situational cognitive distortions:

- Blocked recall.
 - We ask an individual to recite the months of the year. Then we change the protocol to reciting the months in alphabetical order.
 - After reciting 3-4 months (and leaving out several), the individual finds it difficult to recall any month.
 - This demonstrates to the individual and witnesses the rapidity of cognitive freeze, which is a neurochemical. It has nothing to do with intellect or abilities.
 - We provide an escape. Doing anything physical reverses the freeze immediately.
- Attentive freeze (threat-freeze).
 - The individual experiences an abrupt threat and feels the freeze but is fully attentive to the surroundings. They will misinterpret this as being “frozen from fear” or tonic immobility.
 - By pointing out that they had focused attention to detail and the mental preparation for action, they appreciate that attentive freeze is a strength.
- Tonic immobility
 - In its milder form, it appears as active refusal or avoidance to make a decision. The individual feels a “knot in the stomach” or mild nausea. In more severe cases, they may vomit.
 - They do not discuss their intestinal discomfort, thinking it is unique to them and a sign of weakness, or they interpret the sensation as caused by the attending or leader.

“A special relationship occurs at the 1/f oscillation, where an increased power spectrum at low frequencies produces abrupt, rapid fluctuations and catastrophic failure. This is ‘pink noise.’ Pink noise lies between the predictability of white noise (no autocorrelation) and the forcing function of red noise (autocorrelation).”

Pink Noise Abrupt Change

A special relationship occurs at the 1/f oscillation, where an increased power spectrum at low frequencies produces abrupt, rap-

id fluctuations and catastrophic failure. This is ‘pink noise.’ Pink noise lies between the predictability of white noise (no autocorrelation) and the forcing function of red noise (autocorrelation). The variance of pink, or 1/f-noise, differs from other red-spectrum noises in that variance continues increasing regardless of the length of the measured time series (5). Midway between white and red noise, environmental pressure from pink noise equally favors a balance of generalization and specialization (15).

- *Pink noise* (fractal or 1/f-noise) power spectral density is inversely proportional to the frequency with the possibility of low-frequency *catastrophic* events.
- Fluctuations with long frequencies that can cause abrupt catastrophic events are *pink noise* because they are *strictly* between white and red noise or between white noise and the randomness of brown noise.
- Rare events (as forcing functions) are more severe and sudden in the pink noise environment (84), forming a power distribution.

Affect from Pink Noise

The abrupt change associated with pink noise has a more significant effect on the emotional state than the movement of forcing functions that elicit fear-circuit behaviors. Abrupt change becomes an existential threat, eliciting amygdala-driven behaviors (85).

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The distant threat increases activity in the ventromedial prefrontal cortex (vmPFC) which connects to the amygdala to determine the motivational importance of, or degree of, the threat. The amygdala connects onward to the bed nucleus of the stria terminalis (BNST) to control a repertoire of behavioral defensive states (61).

Additional proximal threats will switch activity from the vmPFC to the phylogenetically older midbrain, increasing PAG activity. The PAG controls fast reflexive behaviors (e.g., fight, flight, or freeze) and fear-induced analgesia (61, 63). The release of endogenous opioids in the PAG inhibits the effect of expected pain on decision-making. (The vmPFC is vital for decision-making in uncertain, risky, ambiguous, or context-dependent conditions (50).

The PAG also identifies an approaching or receding threat (62) specific to one of the *greatest* fears, an approaching predator. Detection of changes in distance from threat functionally switches the animal’s repertoire of behaviors (62). Berkun et al. (86) found this from the descriptions of army recruits in dangerous situations. Distance, as perceived physical proximity or time, dominated the thinking of “evacuators,” becoming a determinant for running away.

This movement from contextual decision-making under uncertainty in the vmPFC to reflexive decision-making from the PAG makes the fight or flight of the *fear reactions* appear to be the same as the fight or flight from *threat reflexes*. What it describes, though, is the functional flow of response to a developing danger as apprehen-

sion leads to avoidance (flight), then becomes engagement (self-defensive fight). As a functional approach, *fear reactions* (PAG) develop from distance-based assessments, while *threat reflexes* (amygdala) come from active danger.

The PAG has different functions in its several dorsoventral and rostrocaudal divisions. Dorsal stimulation promotes passive freezing, while ventral stimulation promotes escape and other active coping behaviors (61). From nose to tail, active coping strategies shift from moderate to active defense, then aggressive defense; then strong threat display and *non-opioid*-mediated analgesia; followed by vigorous escape when the enemy is near. When escape from an enemy is impossible, passive coping strategies disengage from the environment, and behaviors shift to freezing, then moderate to solid immobility with increasing proximity. Lastly, intense freezing with *opioid*-mediated analgesia occurs (87, 88).

“ When escape from an enemy is impossible, passive coping strategies disengage from the environment, and behaviors shift to freezing, then moderate to solid immobility with increasing proximity. Lastly, intense freezing with opioid-mediated analgesia occurs (87, 88). ”

Threat reflexes initiate behaviors for survival and adaptation to adverse or hostile environments. Perceptions of threat trigger reflexes that operate below the level of consciousness (LeDoux 2014).

- A fight engages intending to overcome the threat.
- Flight rapidly increases separation to the flight distance previously described.
- Freeze, as attentive awareness with cessation of movement, has two components: 1) focused collection of the necessary information and 2) posture poised for immediate, effective action.
- Tonic immobility, the intense awareness with the inability to move, is accompanied by mild-to-severe nausea and possibly evacuation of body contents.

How they present:

- The fight is manifested by anger and frustration
- The flight takes the form of avoidance and distraction.
- Freeze as a physical freeze is immobility with intense attention, while a mental freeze is an inability to recall knowledge or use working memory.
- Tonic immobility prevents physical movement despite awareness of surroundings, but milder presentations are intense aversion, gastric upset, or nausea.
- Startle reflex scream, an involuntary jerk or “start.”
- Dissociation is depersonalized, emotional numbing.
- Emotional memory presents as a severe response independent of, and disproportional to, the event.

Fight. As described by (58), an animal will attack with emergency characteristics, going beyond self-defense, when an enemy en-

ters the critical flight distance. Separating the motor and emotion components leads to responding with anger (emotion component) without physical contact (motor component).

The prevalence and pervasiveness of relaxed fight responses give the impression that anger is a normal, if not necessary, behavior in an urgent or emergency environment. For example, the immediate reactions observed using the fear responses of anger and force reinforce the belief in their effectiveness. The observed effectiveness, however, is an immediate change toward homeostasis at best while impairing allostatic strengthening.

“ For example, the immediate reactions observed using the fear responses of anger and force reinforce the belief in their effectiveness. The observed effectiveness, however, is an immediate change toward homeostasis at best while impairing allostatic strengthening. ”

Attentive freeze. The body is tense and poised to act; the mind is watchful, collecting information. In prey species, it prevents motion detection by predators. Freeze is the brake on fight-or-flight reactions to learn more, avoid a fight, or prevent a futile flight to failure. Freezing is also associated with faster subsequent cued responses (89).

Information can have multiple meanings, and actions can have more than one effect, contributing to the hypervigilant freeze. This pause can be misinterpreted as denial, indecision, confusion, or waiting for leadership.

Tonic immobility. The person is “frozen” and, despite muscle tone, *cannot* move (differing from attentive freeze), emotionally aroused, full of fear, and unable to call out or respond to pain. However, the person maintains full awareness and consciousness (49, 90). The vagus nerve mediates many of the features of tonic immobility: bradycardia (slow heart rate), life-threatening arrhythmias, decrease in respiration, nausea and vomiting, urination, and defecation.

“Without the behavioral component, tonic immobility appears as nausea when faced with a difficult decision, the “pit of my stomach” feeling. For novices, nausea accompanies their first independent decision and, if unresolved, will inhibit future decision-making. ”

Without the behavioral component, tonic immobility appears as nausea when faced with a difficult decision, the “pit of my stomach” feeling. For novices, nausea accompanies their first independent decision and, if unresolved, will inhibit future decision-making. The individual does not necessarily become trapped in tonic immobility. Kozłowska et al. (49) described actions a Second World War Flying Officer would take when training pilots: he used

a “firm voice devoid of fear to issue simple orders that the men had already learned and that was automatic: ‘flaps,’ ‘raise the stick,’ ‘rudder.’”

Startle reflex.

A stumble, a sudden, loud sound, or a quick movement noticed from the corner of your eye requires reflexive protective action. With rapid body movements, one regains balance, reflexively postures to protect vital organs, and becomes poised for action. Mentally, one assesses information for salience, meaning, and relevance (91-93). Through convergent evolution, Startle became a repertoire of protective behaviors, reflexively bringing protection from disconnected threats represented by sound, sight, and imbalance. More commonly, they present as a single scream (for example, in a scary movie), flexing into the fetal position for protection during a fall (94), or suddenly attending to a “distraction.”

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Vocalizations in the startle response may be misinterpreted as “screaming in panic” when they are involuntary reflexive responses to regain posture, orient toward a threat, and prepare for voluntary movement.

Thought in Pink Noise

Reciprocal decision-making, such as John Boyd’s OODA Loop, keeps one grounded during the flux of events. More significant is the objective of slowing the rate of change. Deterministic chaos develops as the rate of change in the logistic equation increases. From the authors’ experience, reducing the rate of change has a greater effect than choosing entry into the event.

Information

Until the rate of change is decreased, we recommend treating all information as transient, if not ephemeral.

Classification and standardization can solve the problem of information correlation in a white-noise environment. The problem arises from who sets the standards. Making sense in one context does not necessarily make sense in another, even between a physician and nurse standing by the same neonate. “One person’s standard is another’s confusion and mess,” Leigh Star (36)—standardization and communicating across contexts also corrupt information.

However, we caution against reliance on approaches developed in predictable white noise environments. Most likely, they have not been tested in complex or chaotic circumstances and may not support the engagement of forcing functions or abrupt crises. On the other hand, approaches that emerge from effectively engaging forcing functions or abrupt crises can, and do, translate to routine operations.

Conclusion

White noise systems are relatively closed systems limiting energy flow with the environment. The system can readily absorb limited energy, producing a relatively stable state. People may accept the “zero-sum game” where there must be a loser for every winner. People fight to win, and they fight not to lose. There is reliance on discrete concepts, linearity, and classical logic. Expertise is in the form of mastery over cognitive functions; individuals are at risk of having a sense of certitude, even narcissism. There are no outside forces that remind us that the environment always has a vote in our plans.

Red noise systems are open systems with energy freely flowing between the system and the environment. The flux of events touches all those in the system. In red noise, the storm harms all just as the rising tide raises all boats. We are all equally affected by events and help each other, particularly those who cannot help themselves..

There is an ecological hierarchy of problems, however. Problems in a white noise environment tend to be well-structured. In a red noise environment, we can encounter ill-structured problems; in a pink noise environment, problems are embedded in the environment’s stochastic activity.

However, we caution against reliance on approaches developed in predictable white noise environments. Most likely, they have not been tested in complex or chaotic circumstances and may not support the engagement of forcing functions or abrupt crises. On the other hand, approaches that emerge from effectively engaging forcing functions or abrupt crises can, and do, translate to routine operations.

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Liminal people. Those who have sustained liminal experiences find that their values and characteristics have changed (95). They are often marginalized from the dominant account, for example, combat veterans. Combat veterans are reluctant to use and share their experiences, particularly those from the Vietnam era, because of their liminal wisdom (95). Reasoning from experience to apply to present experience seems irrational since the situations are not identical. The combat veteran learned that experience is a process and engagement that relies on constant reciprocal feedback to learn what works through action. Mastery of concepts, a Kantian approach, becomes the dominant account, suppressing interpretations of those constructing reality. Liminality nor experi-

ence, as arts (96), cannot be mastered.

People inexperienced or unaccustomed to operating in pink noise abrupt events will exhibit unrecognized stress reactions and fear responses. We must not use malice if ignorance, stress, or fear will explain the individual's actions.

“People inexperienced or unaccustomed to operating in pink noise abrupt events will exhibit unrecognized stress reactions and fear responses. We must not use malice if ignorance, stress, or fear will explain the individual's actions.”

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Corresponding Author



*Daved van Stralen, MD, FAAP
Associate Professor, Pediatrics
Department of Pediatrics
Loma Linda University School of Medicine
11175 Campus Street
CP-A1121
Loma Linda, CA 92350
Email: DVanStra@llu.edu*



*Sean McKay
Executive Partner / Director, Disruptive Rescue & Austere
Medicine
Element Rescue - Response Solutions within Nonlinear Complex
Environments
Greenville, South Carolina, United States*



*Thomas A. Mercer
Rear Admiral
United States Navy (Retired)*