Introduction
Physical Understanding of Communication
Version 30

Thinking: The brain is a network made of an astronomical number of neurons interconnected by an even larger number of synapses (neural switches). Each of the approximately hundred billion neurons have tree-like arbors that provide myriads of synaptic connections with arbors stemming from other neurons. It is the ***changing of connectivity*** of those synapses both physically and electrically that make up the thinking processes. It is convenient to compare neural structure with acres of rain forests, treating the interaction of branches as synapses. For humans that jungle of connections is packed together in a grapefruit sized sphere we call the brain.

That ***changing of connectivity*** is the result of complex chemical/electrical systems that reduces a myriad of incoming stimuli into specific patterns of output. It is done with a multitude of processes known as ***action potential.*** (See detailed explanation under Miscellaneous Details below)

This note explains how humans use the physics of that network to communicate. In addition it will show some important implications of that understanding.

Cluster: Connected neurologically to every constraint (unit of information) is a network of other constraints. Those networks are defined as ***cluster***s. They represent both the experiences and thoughts of an individual and play a major part in the thinking process. An approximation can be obtained by taking any word and thinking of associated networks. Understanding ***constraints*** (defined below) will significantly enhance the importance of clusters.

Message: A message should be recognized as a ***lessening of values, more precisely of variety.***

Messages are not necessarily associated with words. However, it is convenient to start by recognizing that for every word in a sentence there is a set of values, i.e. variety, and that the use of a sentence (a sequence of messages) reduces each of those sets of variety.

Variety. In the following 13 characters there is variety of 5 letters, 3 numbers, and 2 punctuation characters: 8 y t 5 1 y & g % & 8 k f

Variety is a characteristic of far more than characters. As seen below variety is very broad being applicable to location, taste, communication, pain, etc. everything our senses internal or external can detect. Some examples:

- weather changes
  - storm frequency
  - locational
- behavioral
  - human
  - animal

biological
social
psychological
political rhetoric
locational changes
of objects
of information
communication
mechanical
human
tool
entropy
There is neural element of variety, the element of surprise. For example a TV series can become boring, predictable from your point of view. There is less surprise, less variety. The difference is between your neural expectation and what you experience from watching. This is what Weiner and Shannon called ***entropy***.

Stimuli versus messages

The words stimuli and messages are close to synonymous, ***messages*** being used to emphasize the relationship to communication theory.

Number of stimuli / messages

If you click https://vimeo.com/808732090 on you will get a 12 second video of a gadget the structure and behavior of which is not recognizable. Part of it is taken through a screen. Recognize that each screen opening provides a minimum of one visual stimuli. Now repeat the experiment again using the screen but viewing through just one opening. This should provide strong evidence that our vision is not singular but the result of a myriad of stimuli/messages. The other senses, taste, audio, smell, touch including internal senses are also the result of a myriad of messages, though the screen test obviously isn't available.

Note: a message can be the result of many stimuli and conversely a stimuli can create multiple messages.

The concept of ***difference*** is fundamental to communication be it electronic, human, or neural. In electronic communication a unit of difference is referred to as a bit. There does not seem to be such a label for human or neural communication though the concept of ***constraint*** comes close.

However ***difference*** can be tricky to recognize and is not always agreed upon, for example: climate change or the effect of a medicine..

To survive in a dynamic environment it is necessary to predict behavior. Where in that environment there is a change (difference / variety) there is the creation of messages. When sensed those changes create the neural linkages fundamental for predicting.

Hierarchical

Messages, stimuli and neural structure are organized hierarchically. That structure provides the ability in this massive neural database of potential stimuli to locate what's important and then take necessary steps to deal with it.

Message elements: Communication Theory
Three parts to a message: 1) signal, 2) set of variety and 3) constraint. The **signal** captures our attention, the **set of variety** is that ***to be lessened*** and **constraint** is the characteristic that makes it possible.

Communication: **Electronic** communication consists of a stream of signals; each signal fundamentally consisting of a set with a variety of two. For **humans**, communication is a stream of messages with each message consisting of a signal, a set of variety (two or more) and constraints that makes the reduction of the set possible.

The Social Problem

What makes this effort close to impossible (and fascinating) is that for many fundamental communication concepts our language lacks labels, is misleading or is only superficially understood. To add to the difficulty there is a general lack of recognition of the difference between concepts (what we have sensed either externally or internally) and words or labels, a characteristic of much human communication.

Because you need to know the process to understand the process it is almost impossible to learn. It could be described as a hierarchical structure of chicken or the egg situations.

On top of that there is very little interest in the subject, unfortunate since it contributes to basic understanding of human behavior.

Fundamentals
Physical Understanding of Communication

Collection of stimuli:

Collection of stimuli Collections-of-stimuli are a fundamental element for the Mechanistic Understanding of Human Communication

Imagine you are introducing Bill Smith to your friend. In that process the label for what your friend will first see (and hear) is ***collection-of-stimuli***. It identifies **ALL** stimuli at the moment of introduction including background stimuli such as trees, rugs, noise, temperature, etc.

In a ***general sense*** those that identify Bill (or any other focus of interest such as the result of a rabbit in the garden or a painful foot) are **FIRST** labeled as ***sub-collection-of-stimuli.***

If that ***sub-collection-of-stimuli*** can be remembered (in other words, there is ***recognition***) then that PARTICULAR SUB-COLLECTION-OF-STIMULI becomes a ***pattern.***

Later, if it is provided a label that ***pattern*** may be recalled and/or communicated, for example the label "Bill Smith".

More classifications:

Direct versus ***Associative*** messages: ***Direct***: Sense the sub-collection-of-stimuli directly**.** In other words if you see fire, you feel the heat directly; if you are fed ice cream you detect the taste directly; if you are getting an inoculation, you will feel pinprick directly.
Associative: The sub-collection-of-stimuli is communicated using an association in the mind of the originator such as a label, a word, a sign, a mark, a symbol, etc. Example: in the sentence: *Bill Smith was the person responsible for the gift*. You are receiving sub-collection-of-stimuli not directly from seeing but through the label ***Bill Smith.*** Associative messages communicate sub-collection-of-stimuli far less accurately than direct and play a significant part in social unrest.

An important tidbit
As mentioned earlier the ***t***hree elements of a message are signal, lessening of variety, and constraint. For **direct** messages the sub-collection-of-stimuli (seeing an automobile, tasting lemon) come from learned associations and can vary by individual.

Chain of associations: The collection-of-stimuli being recognized by one party comes through a ***chain of associations*** (very common and not particularly credible)

Neural The communication that takes place within the mind, specifically **hierarchical levels of action potentials**, are fundamental to the other types. They demonstrate how the mind assesses credibility and usefulness of information. See ***action potential***: Dr Jeffery Magee below.

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Creation of language
Words: formal definitions:
The creation of a synaptic link between a label, a word, or a symbol **and** a set of sub-collection-of-stimuli. A couple of examples:
1) When the word IS is used to associate a word (label or unit of variety) with what is being sensed directly i.e. a ***sub-collection-of-messages***, i.e. Bill Smith above)

2) While touching ice: This is ***ice***. The combination of stimuli from one's thermoreceptors and visual receptors makes up a ***sub-collection-of-stimuli*** **t**hat is labeled ***ice***

Informal definitions
We were not born with language. Over the years language has developed from combinations of associations between words and sub-collections-of-stimuli. The generality of some sub-collections-of-stimuli can be hard to detect. For example consider the sub-collection-of-stimuli using the label ***fast.*** It is the common denominator of some automobile movement, the opposite of turtle movement, the speed of light, etc.. To narrow that very broad sub-collection-of-stimuli the word needs to be used with other communication, for example the danger of speed on certain highway.

Neural definitions
In complex ways *sub-collection-of-stimuli* become associated in the mind with other sub-collection-of-stimuli. These combinations are referred to as ***mental states***. Mental states can be unrealistic, i.e. associations resulting from "thinking. Example Putin "Ukraine will be an easy takeover."
On the other hand combinations of multiple ***DIRECT-sub-collection-of-stimuli*** are the basis of credibility.

Mechanics of Communication

Imagine that you and a second individual BOTH have observed https://vimeo.com/808732090 sub-collection-of-stimuli.(and that it is real world not video) To communicate later what you saw **to that other individual** you need a label (a word, a sign, a mark, a symbol) that focuses on that **particular sub-collection-of-stimuli,** (not for the surrounding rug). We will use the label ***Zeb***. That describes the basics for the creation of language.

Depending on the situation the label Zeb may trigger combinations of both types of collections of stimuli, direct and associative.

If both originator and recipient learned **directly** about sub-collection-of-stimuli in contrast to explanation from others (in other words **associative**) credibility is likely to be strong.

Commonly there is a gap (physical, time, locational) between originators (who first sensed the sub-collection-of-stimuli) and the recipient. A chain of links between the originator and recipient is common and necessary. It is commonly quite lengthy and prone to inaccuracies.

End result of a communication

The end result of a communication is a transformation. It may be and often is minuscule. The change may be neurological or physical. Physical refers to environmental changes such as cooking, repairing a car, turning on an air conditioner, etc.. Recognizing the existence of an individual's attempted physical changes provides clues to their mental structure.

Constraints

Definition: For a particular individual in a particular environment, constraints describe ***a neural RELATIONSHIP between two sets (collections of stimuli/messages) that exists when the variety in one situation appearss less than that under another***. (Less precise: under specific conditions the neural relationship between a set and a subset)

Chaos exists when for a particular individual with a specific homeostatic need there does not exist neurologically useful constraints.

Constraints are fundamental for homeostatic survival.

The opposite of **chaos** is **organization i.e.** the neural existence of useful constraints.

Constraint is an abstract (very broad) concept. It necessitates **REFLECTION** for its extraordinary significance to be recognized.

Constraints describe characteristics (pl) of the environment that make it possible to be modified for our needs.

Some Types of Constraints

weather: **general set**: Cloud formations for the last week, **specific set:** Cumulus clouds on particular day at a particular time for a particular individual.

household: **general set**: Bed usually made. **specific set**: Your bed not made at 8:05 September 9, 2022

secret code: **specific set**: Position of a pre-designated stone at 6:04 Dec 9, 1955

physiological: **specific set:** Pain in the third toe of left foot at 7:15 on 3d August 2007 **general set:** sensations from all toes every day.

political: **general set** Probability of civil unrest 2001 to 2022. **specific set** High probability of civil unrest 2023.

location: **general set:** Paperclips somewhere in office, **specific set:** Desk drawer right side. Again mental state for a particular individual at a particular time.

physics: **general set**: random forces**, specific set:** F = MA (specific set since Newton)

resolution of conflict: **general set**; fights, Jan 6, **specific set**: civil behavior, Democracy, peaceful resolution of conflict, our legal system

Some Types of Chaos (lack of constraint)
(Lack of constraints for a particular individual at a particular time)

environmental: unpredictable floods, hurricanes, drought, political unrest

communication: For a particular individual at a particular time in a room where everybody is talking loudly and interrupting.

locational: For a particular individual at a particular time attempting to find a desired object in an unfamiliar and messy home.

medical: interaction of several complex medical conditions

electrical: lack of power to a device even though circuit breakers suggest all is okay

legislation: parts of instructions for personal taxes

informational: often locating a particular constraint such as the name of XXX, or how to fix printer.

In the sentence ***Joe likes corn*** there are at least three messages (1) Joe, 2) likes, 3) corn) For each message there is at least one constraint.

Constraints make up our astronomically sized **neural** database, one that remembers much of our lifetime experiences in **great detail**. Constraints provide the ability to create language, in other words associate a label with a ***collection of messages***. Constraints describe our responses to various situations fire, threats, tastes, etc. Constraints are what we use to assess credibility of a communication.

Credibility

Credibility means for a particular individual at a particular time ***that further exploration will provide results consistent with the original assessment.***

Credibility is a characteristic of both a communication and a believer, not of the real world. ***Water freezes at 32°*** is a communication, the credibility of which is tested by **direct** messages. The word ***consistent*** means that there are ***associations*** for that **particular individual** that are linked to the original assessment.

Credibility results from the buildup of associated credible ***collections of messages*** that are consistent with the original assessment and the **lessening** of ***collections of messages*** that are inconsistent with the original assessment. In contrast to household type on/off messages, neurological ***collections of messages*** create voltage deflections. In turn those volage deflections allow synaptic integration that may cause the firing of an action potential.

Redundancy

Shannon pointed out that ***redundancy*** can improve the likelihood ***that what is received is the same as that sent***. His interest was electronic communication, not human. Redundancy consists

of ***messages that are consistent with a communication***, that are consistent with the set of messages that make up a communication. There are several types: technical, constraint, pattern recognition, etc.

> **Technical**: For the communication ***My car is in the garage*** the technical messages that are consistent with that communication is that there are six words, and 18 characters. If those redundant ***collections of messages*** are not consistent, for example 12 characters, it would suggest that the original ***collections of message*** may have been distorted. A resend may be appropriate.
>
> **Constraint**: Less obvious but more important is recognition that that the above sentence conveys several messages, 1) that he has a car 2) that he has a garage 3) that it can be stored there) so the two sentences ***I have a car*** and ***I have a garage where I can store it*** are redundant. They improve the credibility of the original statement. On the other hand a statement such as ***I have never had a car*** would hurt the credibility of the original statement
>
> **Pattern recognition** A very fundamental element for survival is the recognition of a pattern. Patterns make up the elemental parts of signals, a fundamental element of a ***message***. Neurologically, patterns are defined with **collections of messages**. Frequently there are more ***collections of messages*** than needed for recognition. Those extra ***collections of messages*** are defined as ***redundant***. Though not necessary for message recognition they contribute to credibility, ***that for the believer further investigation will provide results consistent with the original assessment.***
>
> An example: I know that my wife is making supper (a ***collections of messages)*** and that when it's ready the message won't be ***Supper is on the table*** rather it will be merely a grunt, the meaning of which is clear from earlier activity. The five words **supper is on the table** would be ***redundant.***

With human communication the clusters in the mind of the recipient, can provide a significant addition to redundancy. In other words the clusters in the mind of the recipient are vital in assessing credibility. For example if the recipient's (cluster) knows from experience that my garage is so packed with garden equipment that is impossible for a car to fit (the constraint example above). A resend would be appropriate.

A problem is that cluster knowledge can be difficult to predetermine. In addition it can be personalized (with hyperbole, enhancement) differing significantly between individuals.

Homeostasis

Defined as ***keeping physiological variables within their critical limits***. It can be thought of as survival, as physiological ultra-stability.

A better label

Throughout this document I have been using the word ***communication***. The implied characteristic of movement is misleading. A better term would be ***attempted transformation*** in other words the establishment of constraints in the mind of the recipient.

Differences

There is a difference between words, symbols, markings, or signs, and the concepts (collection-of-stimuli) they represent.

A concept that opens the door to this new understanding I have tentatively labeled ***collection-of-stimuli*** and represents changes to an individual's neurological network as a result of stimuli. Those collection-of-stimuli can be single level i.e. a dog, or complex multilevel structures, i.e. ***mass, heat, gravity, relativity.***

A second major difference is the definition of ***message***. It is defined as ***lessening of a set of values.*** The ***values*** are ***collection-of-stimuli***. ***Communication*** is merely a string of ***messages.***

Contrast that to some dictionary definitions that don't provide physical enlightenment:

- *A verbal, written, or recorded communication sent to or left for a recipient who cannot be contacted directly.*
- *US an official or formal communication, especially a speech delivered by a head of state to a legislative assembly or the public Congress.*
- *an email or similar electronic communication: select an option to delete your mail messages.* •

Learning this subject is difficult because it requires learning a hierarchic structure of chicken or the egg situations.

Benefits

You need an association to remember, sometimes rather subtle but a major aid in remembering.

We are not born with a vocabulary, it is learned.

There is no such thing as real-world credibility; instead it is the credibility of the communication of that phenomenon.

The word ***information*** is misleading. It does not give guidance to its technical side. It is better thought of as ***constraint***, defined below.

We communicate not with words but with networks of collection-of-stimuli.

What we **see** is not singular, but the results of a massive number of stimuli.

Constraint is defined as ***the relation between two sets when the variety under one condition is less than that under another***. It is a very broad concept relating to everything we can sense and or create mentally. It is the opposite of chaos, and it represents a unit of information**.** YOU CAN'T SEE *CONSTRAINT*. YOU CAN ONLY TEST WHAT IS SENSED AGAINST THAT DEFINITION.

A message necessitates two values; in other words you cannot communicate a single value.

Messages or ***communication*** is better thought of as **attempted transformations** for homeostatic purposes (of people, the environment, and/or the mind).

Variety, defined as ***amount of difference in a set of values*** is close to fundamental in understanding many of the concepts behind Mechanistic Communication.

Example: In the following sequence of 9 alphabetic characters: x x x z b y b s f there is ***variety*** of 6 characters (x z b y f). However variety is far broader than alphabetic characters; it is characteristic of almost everything we can sense and or think about. Examples: location, of either objects or information, mechanistic behavior, level of surprise, environmental, psychological, chemical, etc.

Some learning comes from COMMUNICATIBLE items. However, that database is minuscule compared to the massive databases in the minds of individuals. For example: where is the toothpaste, which pants to wear tomorrow, how to get the air conditioner to cool more, do I need a haircut? slight pain in left shoulder, bored, what to do about bad milk, where are the toothpicks stored. It is a database that is LEARNED NOT FROM LANGUAGE BUT FROM EXPERIENCE.

Miscellaneous Details
Physical Understanding of Communication

Action potential: A fundamental function of nerve cells is the transformation of incoming synaptic information into specific patterns of action potential output. An important component of this transformation is synaptic integration — the combination of voltage deflections produced by a myriad of synaptic inputs into a singular change in membrane potential. [An action potential is a very complex physical, electrical, and chemical transaction the details of which can best be obtained from other sources. What is significant is that a neuron receives a myriad of inputs/messages which firing translates to a singular output.] (Dr Jeffery Magee, Baylor)

Aspect: For almost everything we do or learn there are multiple associated changes. For example if I eat breakfast the food supply is diminished, my glucose contents improve, the time changes, there are dirty dishes. The label ***aspect*** refers in a general way to any of those changes. A precise understanding is important because it describes an attribute about communication.

Associated: connected neurologically with synapses.

Ascoli Principles:

First: Mental states correspond to patterns of spikes in the nervous system.

Second: The continuous tweaking of the synaptic connectivity among neurons alters the knowledge of each individual (that is, the available repertoire and specific content of mental states), in every single moment throughout the life span.

Third: The instantaneous patrimony of neuronal connections strongly constrains the selection of synapses an individual can form anew.

Axons: The neural arbors that give out information.

Communication levels: Humans communicate at multiple levels. Generalities (higher level language) are used to introduce a subject while specifics are necessary for detailed understanding.

Consistent: Connected neurologically. The word ***consistent*** means that there are neural connections (associations, synapses) linked to the original assessment. Importantly, though there may be similarities to others those associations are for a particular individual. This is important in the understanding of why there is so much difference of opinion.

Cybernetic-math: It is similar to geometry except that instead of relating to space and shapes the vocabulary relates to change, difference, and communication. The concepts behind that vocabulary are not obvious. They have been carefully and systematically explained in W. Ross Ashby's ***Introduction to Cybernetics.*** Ashby provides very precise definitions of these concepts

along with a clever, though time consuming way of learning them. Recognizing them in everyday situations, particularly communicative, requires a lot of reflection.

Dendrites: The neural arbors that collect information

Direct versus ***associative*** communication: ***Direct*** communication is that that gets to the mind DIRECTLY from the various sensors. ***Associative*** gets to the mind INDIRECTLY by an association with a direct communication made at a different time possibly by a different person. Credibility of ***associative*** communication is generally much less. Muddying the waters even more, see ***pseudo-direct***

Information entropy. As we go through life, we are recipients of a constant flow of constraints. Our minds have the ability to categorize those constraints **by degree of predictability**. ***Information entropy*** defines the level of unpredictable constraints (in other words potentially useful information). A TV program that gets repetitive provides little entropy. That mental ability gives a feel of the astronomical magnitude of the mind to remember constraints.

Message structures: A combination of messages (***collections-of-messages)*** valuable for improving predictably. Models, algorithms, formulas, etc.

Noise: ***Collections of messages*** that have little or no affect on behavior.

Pseudo direct collection of messages: Digital photo and video. Similar to ***direct*** with the exception that it can and commonly is easily distorted.

Synapse A synapse is a *neural connection,* a *switch,* an *association.* In a neural network the impact of a closed switch is a **voltage deflection** on the unitary postsynaptic neuron. This contrasts with an ordinary household network where the impact of a switch on the related device is **on** or **off**.