A Mechanism for the Human Thinking Process

A Hypothesis in Cognitive Neuropsychology

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The Evolution of the Human Survival System

The mechanism that evolved into the human thinking process originated over three billion years ago in single-celled creatures that, ironically, don't have a brain to think with. These single-celled creatures always respond automatically (i.e. "emotionally") to the stimuli they detect and always respond to the same stimulus in the same way. No choice of any kind is possible. Those creatures that responded by moving toward objects that promote their survival and away from threats survived; all others died out. To this day, the survival of every creature from single cells to humans depends on its responding appropriately to the stimuli it detects.

The single-celled survivors of this dramatic evolutionary shakeout have a survival system of only three elements. This system consists of a "detector" that reacts with a specific type of stimulus, some way to transmit the information of this detection, and a "motor" that moves the creature toward or away from the stimulus. The information is transferred from the detector to the motor either by a messenger molecule (a "hormone") or by a series of chemical reactions. A different set of these elements exists for each type of stimulus the creature can detect. That's all there is to it, yet this simple system is so effective that it continues to operate after billions of years.

Nevertheless, the basic survival system has a serious shortcoming. It cannot distinguish among different sources of the same stimulus. For example, this mechanism has no way to know if a shadow it detects represents a harmless rock, a hungry predator, or possible prey. Also, the creature always responds to the same stimulus in the same way, which might not be the best response for the specific stimulus detected. So, at some point in the evolution of multi-celled creatures, a fourth element was added to form the "advanced survival system." The advanced survival system did not replace the basic system but added to it. All the activities of the basic system remain unchanged. The one new element in the advanced system evolved into the brain. Although many bells, whistles, and new tasks have been added, there are still only four elements in the advanced survival system.

As in single-celled creatures, a detector in an advanced creature releases an impulse when it detects a stimulus. This impulse is transmitted to the brain as well as to the motor. The brain extracts some additional information from the ir pattern of impulses it receives from the detector. For example, one pattern of impulses might show that the source of the stimulus is stationary rather than moving. This additional information might cause the brain to send a signal that stops the motor from moving the creature unnecessarily.

The elements in the survival system evolved as multi-celled creatures evolved. The detectors became sensory organs. The messenger molecules became neurotransmitters. The motor became a network of muscles. That puny new element became a complex brain of over 100 billion neurons. Yet their basic functions did not change. The sensory organs still detect stimuli and send this information to the motor cortex, which still responds automatically to the stimulus. The brain still extracts additional information from the sensory signal, assembles all the information it already has about the stimulus, and sends an “intellectual” signal to the motor cortex. This intellectual signal still modifies the emotional response in a way intended to increase that creature’s chances of survival.

It is relatively easy to examine the primitive brains of simple creatures to learn that all members of the same species always have the same number of brain cells interconnected in the same way. It is also possible to trace the route of the impulse that occurs when a stimulus is detected to learn that it always passes through these cells in the same way. In short, these creatures have no mechanism that permits them to choose a response to a stimulus.

When a creature’s brain reaches some level of size and complexity, it begins to respond to the same stimulus in different ways. That is, they seem to be choosing their response to the stimulus. This process of selecting a response to a stimulus is “thinking.” As it is not possible to trace the signals in these larger brains, we cannot know if this is really a choice or is still only an automatic processing of the connections of the neurons in that brain at that time.

Shortcomings of the Human Thinking Equipment

Nature did not start from scratch to design a survival system to handle the specific needs of each new creature that evolved. It simply took whatever equipment the creature’s immediate ancestors had and added a few connections here and a dash of something there. Some changes improved the new creature’s chances of survival, but some equipment that worked fine in an ancestral creature didn’t fill all the needs of its descendants. As a result, some inappropriate responses to stimuli (i.e., “errors”) in advanced creatures occur because of shortcomings in their mental equipment. An individual will always make these errors inherent in the equipment unless he or she does something to avoid them. The following brief description of the human thinking mechanism will show some of the many ways these errors occur.

The Senses

The human brain contains billions of nerve cells (i.e., “neurons”). It starts with no information of any kind about the outside world. Every item of information it receives comes to it from its senses. If a creature’s senses do not detect a stimulus, either directly or in a communication from others, it has no way to know that the stimulus exists.

When the detector of a primitive creature detects a stimulus, it discharges an impulse. This impulse reports that a stimulus has been detected but contains no information of any kind about the stimulus. A primitive creature then responds directly to the stimulus it detects, but has no idea what that stimulus is. As a result, it has no way to know what it eats or what eats it.

People occasionally respond directly to a stimulus without identifying it first, as in withdrawing from a hot object. More often, however, they respond not to the stimuli they detect, but to the source of these stimuli. For example, a person responds not to the molecules detected by his or her nose but to the food that is the source of those molecules. As a result, a major objective of the human thinking process is that of identifying the <u>source</u> of the stimuli it detects, which will be described later.

<u>Sensory Detection</u> – The individual detector cells in human sensory organs still operate in the same way they do in primitive creatures. When a sensory cell detects a stimulus, it releases an impulse that reports that something has been detected but provides no information on what that something is. For example, each human eye contains more than a hundred million detector cells, each of which detects only a specific type of stimulus. Because more impulses are generated in each unit of time than can be transmitted before the next set of impulses occurs, all impulses detected simultaneously are compressed and sent to the brain as an irregular pattern of impulses, rather like the bar code on a grocery product. This pattern of impulses will be called the “sensory signal.” The sensory signal contains no information about the stimuli detected; the only information it contains (and in code!) is which detectors have discharged an impulse.

<u>The Sensory Signal</u> – Each human sensory organ detects all the stimuli within its range in each instant of time. This set of stimuli might have originated in a single object or in several different objects. Each different set of stimuli forms a sensory signal with a unique impulse pattern. This sensory signal is conducted over the route (i.e., “pathway”) that best fits its impulse pattern to reach some set of neurons in the cortex.

<u>The Sensory Pathway</u> – The term “pathway” is used for convenience, but it is quite different from a path in a forest. The individual impulses in the sensory signal are conducted over a large number of routes so that the signal proceeds as a “front” consisting of many individual pathways.

Each nerve cell in the brain is interconnected with many others through tiny gaps called “synapses.” Each neuron can receive impulses from several other neurons through these synapses. When their combined impulse reaches a critical voltage, the neuron discharges an impulse that releases neurotransmitters into the outgoing synapses connecting it with other neurons.

<u>The Recall of Memory by Re-detection of the Stimuli</u>

Each sensory signal is conducted through the brain structures along a route determined by its impulse pattern to reach some set of neurons in the cortex. At some point in its route through the cortex, the information in the sensory signal reaches consciousness, which will be called the “sensory pattern.” Later detection of the same set of stimuli forms the same sensory signal, which is conducted over the same route to form the same sensory pattern. That person is aware that he or she has detected this pattern before. That is, he or she “remembers” the pattern, even though he or she doesn’t know what it represents.

This mechanism provides three important clues to the nature of memory:

1. A memory can be recalled by re-detection of the stimuli that formed it.

2. A memory is not stored somewhere in the brain, gathered up, and brought to consciousness in some way. Instead, a memory is re-formed by stimulating the same set of cortical neurons.

3. The information in a memory is stored in its route to the cortex.

Another mechanism for recalling a memory will be described after some necessary groundwork is presented.

<u>Enhancement of Synapses</u>

The passage of an impulse over a synapse increases the quantity of neurotransmitter it will discharge if used soon thereafter. The more frequently a synapse is used, the greater the quantity of neurotransmitter it discharges, up to some maximum level.

Immediately after use, a synapse begins to lose its enhancement and returns eventually to its unenhanced level. The first time a synapse is used, it loses its enhancement within a few seconds. Enhanced synapses lose their enhancement more slowly, typically over days or weeks. Re-use of a synapse before its enhancement is entirely lost restores its maximum enhancement.

The enhancement of the synapses along a route for a sensory signal is rather like constructing a pathway through a dense forest. As a result, the same impulse pattern is more likely to be conducted over an enhanced pathway to reach the same set of neurons in the cortex.

If the synapses in a pathway are not used for some time, they begin to lose their enhancement. At some level of deterioration of the enhancement of its synapses, a pathway is no longer able to conduct some or all of the sensory signal that formed the pathway. As a result, some or all of the information that was recorded in the enhancement of those synapses is “forgotten.”

The information in a memory often changes during storage. Some or all of it might be forgotten. Items not in the original event might be added. Associated items might replace an original item. As a result, most memories do not accurately represent the events that formed them.

Most creatures encounter more information in a lifetime than they can store and recall quickly. Nature handled this problem by having the brain retain only those items detected frequently. While “forgetting” is disadvantage in some cases, It’s the only way to remove incorrect, useless, or painful information from the brain.

<u>Similarity</u>

These sensory pathways have another important function in the human thinking process. In primitive ancestral creatures, speed in responding to a stimulus was more important than identifying it precisely. They didn’t need to know if the prey or predator was young or old, male or female. So instead of forming a new pathway, a sensory signal with an impulse pattern similar to an earlier signal is conducted over its enhanced pathway. This new signal reaches the same set of cortical neurons as the earlier signal and so is interpreted in the same way. As a result, unless the brain already has additional information that distinguishes among similar signals, it interprets similar items as being identical.

This misinterpretation of similar items as being identical has both advantages and disadvantages for people. Without it, verbal communication would be impossible, as a person would not interpret the similar but different sounds made by different people as representing the same word. On the other hand, similarity conceals minor differences in an object, which is why all tigers or all Oriental soldiers look alike and why people aren’t aware of the gradual changes they detect in people they see often.

<u>Incomplete Detection of Stimuli</u> - The degree of difference in sensory signals that the brain treats as similar is quite wide. People often detect an incomplete set of stimuli for a familiar object, as in seeing it in a fog or partially occluded by other objects. Nevertheless, the image of the complete object comes to mind. For example, a person who catches only a glimpse of an object in a forest nevertheless recognizes it as a deer.

In these cases, the stimuli detected are a partial but not complete set of the stimuli that represent that object. Nevertheless, when the impulse pattern for a partial set of stimuli is sufficiently similar to that for the complete set, it is conducted over the enhanced pathway to reach its set of cortical neurons. As a result, the partial set of stimuli is interpreted as the complete object.

Associative Memory

The human senses detect all the stimuli within their capacity at each instant of time. All the stimuli detected simultaneously form a single sensory signal that is conducted over a pathway determined by its impulse pattern to reach some set of neurons in the cortex.

For example, a person on vacation meets and spends some time with a John and Betty Smith. The sensory signal formed contains the impulses for the images of both people. It is conducted along a pathway determined by this impulse pattern to form a composite thought pattern (to be described) which is interpreted as John and Betty Smith.

Later that day, this person meets John Smith in an elevator. The sensory signal formed might construct a new pathway to record the image of John Smith alone. However, if this impulse pattern is sufficiently similar to that for John and Betty Smith together, it will more likely be conducted over that established pathway. In this case, the sensory signal reaches the earlier set of cortical neurons and so brings both John and Betty Smith to mind.

When the detection of one object also brings an undetected object to mind, the objects are said to be “associated.” This process is known, appropriately enough as “associative memory.”

Indirect Associations – The detection of a set of stimuli sometimes brings an item directly associated with it to mind. This associated item might then bring a third item with which it is associated to mind, and so on. This process can result in a chain of directly associated items. The other members of a chain of directly associated items are associated indirectly.

This mechanism for associating items indirectly has great survival value. When a creature detects a set of stimuli, this mechanism instantly selects from all the items present in that brain only those associated, directly and indirectly, with the stimuli detected (to be described later). The associated items are then used to arrive at an appropriate response to these stimuli.

Associative memory also helps survival when prey or predator is not detected completely. For example, a prey animal associates a certain smell with a predator. When it detects this smell again, it immediately flees, even though it has not seen the hidden predator.

The Thought Pattern

The principle function of a thought pattern is that of assembling and processing all pertinent information in that brain about the stimuli detected in order to respond to them appropriately.

As many activities are occurring simultaneously in a thought pattern, it is not possible to describe them chronologically. However, what is going on should be clearer once the pieces in this puzzle are put together.

Forming the Thought Pattern – A continuous series of sensory signals succeed each other in entering the cortex. Each sensory signal is conducted through the cortex along a route determined by its impulse pattern; that is, by its information content.

At some point along its route, the information in a sensory signal is brought to consciousness for an instant as a picture, a sound, a taste, etc.

Each signal continues without pause beyond this point of consciousness. The route that it takes is determined by the interconnections of the neurons in the cortex. This route will be referred to as “processing” the sensory signal.

The partially processed sensory signal leaves the cortex. Some of this processed signal becomes the emotional signal to the motor cortex, where it initiates an immediate response to the stimuli detected. Some is returned directly to the cortex for further processing. Some of the partially processed signal is sent back to earlier locations in the route of the sensory signal, where it joins the incoming sensory signals.

As this “recirculated signal” returns through the brain structures, it triggers the pathways of stored items (i.e., memories) associated with the items it contains. This brings these associated items into the cortex where they stimulate additional neurons. The entire set of cortical neurons stimulated simultaneously, whether brought to consciousness or not, will be called a “thought pattern.”

Each thought pattern is constantly changing as successive sensory signals bring into it impulses for new stimuli and their associated items while signals from earlier detections expire through habituation.

Recirculating Signals – As noted earlier, the principal function of these recirculated signals is that of bringing items directly and indirectly associated with the stimuli detected into a thought pattern. These indirect associations include not only impulses representing specific objects but also connections among objects. These connections range from the specific, such as “ice is frozen water,” to quite broad interpretations of the world, such as “it’s all right to lie when necessary,” “never show fear,” “a good offense is the best defense,” etc.

Recirculating signals have at least two other important functions. Without them, the brain would respond to each individual set of stimuli detected, as by responding to each word in a sentence instead of the meaning of a sentence. In effect, recirculating signals convert a series of individual thought frames into a continuous activity.

Recirculating signals also provide the mechanism for conceiving of everything that is not real. The sensory signal that forms when a stimulus is detected in nature always represents something that is present in the real world. However, recirculating signals bring into the thought pattern impulses for items that were detected at different times and in different places. In trying to identify the source of this combination of different sensory signals, the brain sometimes combines the impulses for an ear of a rabbit in one impulse pattern with the body of an elephant from a different impulse pattern, and interprets this combination as an object, even though that object does not exist in the real world.

Combining sensory impulses into new forms is a mixed blessing. On the plus side, it makes possible useful inventions, new procedures, planning for future events, and so on. Also, if this mechanism did not exist, it would be impossible to associate items that were not detected in the same place at the same time, so there would be no way to identify causes and their effects.

On the negative side, recirculated signals form objects and concepts that do not exist in the real world, such as aliens from space or evil spirits, making it much more difficult to identify the real world correctly. Some people have so many imaginary objects in their brains that they cannot function effectively in the real world.

Purpose of the Sensory Pattern – The sensory pattern evolved to assist creatures identify the stimuli they detect. However, this does not occur the first time a new sensory pattern is formed for two reasons. First, the sensory pattern is simply a set of energized neurons. It is similar to a photograph a person has not seen before. The only information he or she can use to interpret the picture is that present in the sensory signal. As a result, this person has little or no idea what the sensory pattern represents or how to deal with it. It is only after the recirculating signals bring associated information into the thought pattern that the sensory pattern might (or might not) be interpreted correctly and an appropriate response formulated.

Secondly, the sensory signal continues through the cortex without waiting for an identification of the stimuli present. When this first rough interpretation of the sensory pattern is threatening, the partially processed signal causes an emotional response even before the sensory pattern is interpreted. Examples are touching a hot object or hearing a shout of “Duck!”

The response is quite different when the same sensory pattern occurs again at a later time. Here again there is an immediate response to the limited information in the sensory pattern. However, the recirculating signals gather up the information learned from previous encounters with these stimuli. This experience is used in processing the available information to arrive at the response most likely to promote the creature's survival. As all information used in response to the stimulus is already present in that brain, the human response to stimuli might also be automatic, as it is in primitive creatures.

Interpreting the Sensory Pattern – We want to know what made that noise, what that smell represents, and what that peculiar object is. That is, we try to interpret our sensory patterns.

Soon after the sensory pattern is formed, recirculating signals bring associated items into the cortex. The interpretation of the sensory pattern is based entirely on the information in the thought pattern. All information in the thought pattern must be considered in interpreting the sensory pattern and no information that is not present in the thought pattern can be used for this purpose.

How does the brain interpret what all these impulses represent? It doesn't. The brain has no mechanism to interpret its sensory patterns. It simply processes these impulses through its synapses to arrive at a response to the stimuli detected. Creatures that respond appropriately to their sensory stimuli survive; all others die off. Even today, people often respond to stimuli without knowing what they represent.

As the brain has no way to interpret the impulses in the sensory pattern, it assumes what they represent. Since each person's information about the items in a thought pattern might be a correct or an incorrect interpretation of the real world, his or her interpretation of the sensory pattern might also be correct or incorrect. Moreover, the brain has no internal way to check if its assumptions are correct or incorrect.

Every sensory pattern for every object or combination of objects had to be interpreted by some person. As only one of many possible interpretations of a thought pattern Is correct, most interpretations by our ancestors were incorrect. They really saw the chariot of a god moving across the sky or felt the gods come out of the earth in spring. Nevertheless, through trial and error over many thousands of years, earlier incorrect interpretations have been replaced with less incorrect interpretations until no other interpretation seems more likely to be correct, at least for now.

Associations with a Sensory Pattern – An individual might associate a sound with some portion of a sensory pattern, thus giving it a label, such as "rock" or "tree." When this sensory pattern is detected later, it brings the associated sound to mind. These labels identify rather than interpret the sensory pattern. Nevertheless, as it is much easier to deal with labels instead of the sensory patterns themselves, these associations greatly facilitate the thinking process and make verbal communication possible.

Primitive creatures usually detect only one type of stimulus from one source at a time. Advanced creatures, including humans, usually detect different stimuli from different sources simultaneously. However, the human brain continues its ancient practice of attempting to interpret each sensory pattern as representing a single object. When this fails, it attempts to identify individual objects within the pattern. Nevertheless, the brain still assumes that all items in a sensory pattern are connected in some way in the real world. As a result, the objects in a sensory pattern are “associated.”

When the information in a thought pattern completely and correctly identifies the stimulus and how to deal with it, that person’s response achieves its objective. When the information is incomplete or incorrect, the response is always less beneficial than the ideal response would have been.

The Intellectual Signal

The processed information in the thought pattern is sent to the motor cortex. This “intellectual signal” merges with the emotional signal that arrived a fraction of a second earlier. When an immediate response is required, the emotional signal directs the response before the intellectual signal arrives. In all other conditions, these signals merge to initiate a composite response to the stimuli detected.

The composition of the composite signal is determined by the relative strength of the emotional and intellectual signals. The strength of the emotional signal is determined by the effect the stimuli detected might have on that person’s survival. For example, the emotional response is stronger to detection of a wild tiger than to a house cat and stronger to a promotion at work than to a modest increase in salary.

The strength of the intellectual signal is based on the volume of information, correct or incorrect, in that person’s thought pattern about his interpretation of the stimuli detected and how to deal with them. In some cases, the intellectual signal is strong enough to dominate or suppress the emotional signal.

Both the emotional and intellectual responses are based on that person’s interpretation of the stimuli detected and not to the actual stimuli. That is, a person will have a strong emotional response to a dry stick he interprets as a poisonous snake yet might fail to respond to the threat of a puncture by a rusty nail, which he considers to be harmless.

Feelings - The composition of the composite signal is reflected in the internal "feeling" it generates. A person feels good when he or she detects stimuli that are interpreted as contributing to his or her survival. He or she feels bad when the interpretation of the stimuli represent a threat to survival. He or she also feels good when the response achieves its objective of obtaining a benefit or escaping a threat and feels bad when the response fails to obtain a benefit or to escape a threat.

For example, a person has a strong negative emotion to a diagnosis of cancer. As most people have little information about how to deal with cancer, the intellectual signal is weak. This combination of a strong emotional and a weak intellectual signal results in a feeling of dread or panic. As this person learns more about modern techniques to deal with the cancer, the strength of his intellectual signal increases so that the intensity of his negative feeling decreases, perhaps to worry or concern.

Loading the Data Base

The brain constantly encounters new items of information. These items are not all handled in the same way. How the brain handles each item it encounters depends on:

- How different the new item is from the information already present in that subject area.

- How much information of each type is present in that subject area.

Each new item is incorporated into one or more thought patterns. Any item that is different from the information present changes the thought pattern and so modifies the response to the stimulus.

First Information – As it is the only information the brain has about that subject, the brain uncritically accepts as correct the first information it receives in a new subject area, whether or not this item is a correct interpretation of the real world.

Compatible Items – A compatible item does not change the nature of the response to the stimuli significantly. As a result, the brain uncritically accepts as correct all items that are compatible with the majority of the information already present in that subject area, whether or not the new item is correct.

Contrary Items – A new item that is different from the present information might be "contrary" or "contradictory." A contrary item is one where the brain can incorporate the new information with its present information, even though the new item significantly changes the interpretation of the thought pattern. For example, someone might have information that all American Indians were hunters. He then learns that some were farmers, which is significantly different from his present information. However, this is resolved by interpreting the thought pattern as some Indians were hunters and some were farmers. As a result, contrary new items are accepted as correct, whether they are or not.

Contradictory Items – Some new items cannot be incorporated into the information present. An object cannot be both intact and broken simultaneously. The earth cannot be both six thousand and four billion years old. When the brain cannot come up with any interpretation that includes the new item, it omits it. In effect, new items that are contradictory to the present information in that brain are automatically rejected as incorrect, whether they are or not.

Suppose a primitive creature has information that a certain stimulus is a benefit. It then learns that this stimulus is a threat. When this stimulus is detected again, this creature would attempt to approach and withdraw from it simultaneously, which is impossible. So the thinking mechanism evolved a way to prevent this impasse from occurring.

This mechanism was brilliantly shown by Dr. Pavlov's experiment with a dog. Dr. Pavlov sounded a buzzer of a given frequency when he gave the dog some food, after which the dog approached when it heard that sound again. Dr. Pavlov sounded a buzzer of a distinctly different frequency when he gave the same dog a mild electric shock, after which the dog withdrew when it heard that sound again. Dr. Pavlov then gradually brought the two sounds closer together until the dog could not distinguish between them. As a result, the same stimulus represented both a benefit and a threat. The dog repeatedly tried to approach and withdraw simultaneously until it had the equivalent of a human "nervous breakdown."

Effect of the Quantity of Information

- When a person has very little information in a given subject area, a single contrary or contradictory item can modify the thought pattern considerably. Under these conditions, a person can "change his mind" rather easily.

- As the quantity of compatible information in a person's brain increases, detection of a contradictory item has progressively less effect on the thought pattern and therefore has less influence in changing his/her response to the stimuli detected.

- At some level of compatible information present, detection of a contradictory item has negligible effect on the response. In effect, the new item is automatically rejected as incorrect, regardless of whether it's correct or incorrect. So correct information blocks the acceptance of

> incorrect information, but incorrect information just as effectively blocks the acceptance of correct information.

An interesting example of this mechanism is the spell checker in a computer program. The computer program contains the correct spelling of a large number of words. When one of these words is spelled differently, the spell checker automatically rejects it as incorrect. However, words not present in the program can be added. As this is the computer's first information about this specific word, this spelling is automatically accepted as correct, even when it isn't. If this word is then spelled correctly, the computer automatically rejects it as incorrect because it's contradictory to its information.

<u>The Correctness of an Item to the Brain</u> – The brain has no internal way to check if any item of its information is correct or incorrect. As a result, the correctness of an item to the brain is determined entirely by its compatibility with the majority of the information present.

<u>Errors in Processing Information</u> - In addition to these errors in the way the brain handles new information, errors also occur because of the way the brain processes its information to arrive at its response to stimuli.

- The brain has no way to know if it has all the information needed to respond appropriately to the stimuli detected. It is only through experience in other subject areas that we can suspect that there might more information than we have on this one.

- The brain bridges some gaps in its information with "assumptions," which might or might not be correct. As the brain has no internal way to recognize these assumptions, they are often mistaken as facts.

- The brain assumes that all its interpretations of objects and their connections are correct, whether they are or not.

- The brain has no internal way to know when its correct information becomes incorrect, either because the environment has changed (i.e., "obsolescence") or because incorrect new items of information outweigh the correct items in a given subject area.

<u>Measurements</u> – The human brain cannot measure anything directly. The brain can compare, but it cannot measure. If two similar objects are detected simultaneously, the brain can tell that one is longer, brighter, pointier, etc. than the other, but it cannot measure how long, how bright, etc. an object is.

All measurements must be made by comparisons. A measurement is correct only when it is made under the following conditions:

- The object being measured must be identified completely and correctly. Otherwise, the result might be affected by an impurity, a defect, or a factor not identified correctly.
- The object must be measured against a known standard that is identical with the object except in the one aspect being measured.
- A direct sensory impression by a person is required to detect the difference between the object and the standard.
- The person making the comparison must be both accurate and objective.
- All extraneous factors in the system must be eliminated. If this is not possible, they must have the same effect on both the object and the standard. In this case, the measurement is valid only for this set of conditions.

The result of the measurement of one object cannot be transferred to some other object or even to some other aspect of the same object, and certainly not to a value judgment, such as which object is “better” than the other.

As it is impossible to devise a suitable standard for most intangible items, such as beauty, morality, success, etc., all such measurements are meaningless.

AFTER WORD

This hypothesis of the human thinking process doesn't paint a pretty picture. It shows that we have no way to know when we don't have enough information to respond to a stimulus appropriately. There are so many gaps in our knowledge that we are obliged to bridge them with assumptions. Moreover, we have no way to know which items in our interpretation of the real world are correct and which aren't. It's rather like a crazy house in an amusement park or a scene from Kafka's stories. You never know what's real and what isn't.

Yet what explanation other than an imperfect thinking process could account for the destruction of untold millions of people by wars, by tyrants, or for different religious beliefs? What else would cause merchants to sell products they know will kill or injure users? Why do people destroy themselves with alcohol and street drugs? Then there is slavery, sexual abuse of children, domestic violence, white-collar theft, etc., etc. Can there be any basis for these activities other than errors inherent in the human thinking process?

Nevertheless, almost unnoticed in this carnage, there has been slow but steady progress over the millennia. The human brain evolved to serve only the person of which it is a part. Its basic response to the detection of a stimulus is to flee from predators and to violently attack other creatures, including other people, to obtain its physical needs for survival. No one could survive otherwise. Nevertheless, as the human brain accumulates information, its intellectual response becomes stronger. At some point, it can control, at least partially, its violent response to stimuli. Eventually, more people will understand that in helping others in need, they might also be helping themselves.

In short, the hope for the future is in obtaining more correct information about the world we live in so that the human intellect will be able to control our naturally violent emotional response to stimuli.