

THE SENS-IT CELL MODEL

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The Sens-it Cell Model of Language Teaching is an attempt to synthesize the latest scientific findings from a variety of disciplines into a single unitary model. It is viewed as both a theoretical approach and a basis for practical application. The Sens-it Cell Model is based upon a certain set of assumptions about the nature of language, the nature of human behavior and the nature of the teaching/learning process which are not necessarily widely recognized and therefore require further clarification. In this model, the nature of language is perceived to be something which takes place only in the brain, human behavior such as speaking, is seen as controlled through feedback and teaching and learning are considered to be the practice and theory of growing language information in the brain which provides the basis for feedback control. The practical implications of the model are that listening comprehension should be taught carefully and completely from the very beginning. Speaking practice should be delayed until comprehension is well underway. (Winitz, 1981)

The name and conceptual framework of the Sens-it Cell model was derived from the SEN: SIT concept first formulated by I. A. Richards, and the principle of SELECTION which comes from cognitive psychology's hypothesis testing theory of learning. The SEN:SIT:SEL formulation was changed to Sens-it Cell both for euphonic purposes, and to serve as a reminder that the theory of feedback control underlies the model as well.

The SEN:SIT concept was formulated by I. A. Richards (Richards, 1968) and has been applied to his *Language Through Picture Series*. The SEN:SIT concept is based on the belief that

meaning in language communications is derived from the culturally coded association between a SENTence and a SITuation. The SENTence is considered to be any publicly observable aspect of the language signal system which has semantic or syntactic implications. This is the side studied almost exclusively by linguists, and it has often been identified as the language itself. The Sens-it Cell Model assumes the SENTence part of language as only a part. A SENTence can be passed between people, but it has no meaning. It does not become language according to this model until it transfers information by releasing some meaningfulness in the receiver. We are continually surrounded by radio signals, but we are both unaware of them and ignore them, until they are transformed into something meaningful to us by a tuned-in radio receiver. Our brains are the turned-in radio receivers for language SENTences, and these SENTences are transformed into meaningful SITuations for us in the brain. Thus the Sens-it Cell Model assumes that language can only take place in the brain.

The SITuation part of the model is the general category of meaningfulness. In the public sense we often look at the SITuation through the actions of people and/or through pictures. While these are more direct representations of meaning, the SEN:SIT concept refers primarily to the internal brain functioning between these two aspects of language: signal and meaning. The SITuation tends to be meaningfulness held in memory from direct sensory experiences and built up through abstraction processes and SEN:SIT input from others. The SITuation is associated with and attached to a SENTence unit through the learning process. For example, the word "dog" tends to be associated with our direct sensorial experience with the animal we refer to as a dog. Language learning involves the process of making these SEN:SIT associations. Language learning is thus seen as a process of associating a signal with a meaning, a SENTence with a SITuation. Language teaching

consists of inventing, arranging, presenting and testing with immediate feedback, the various SEN:SIT's of the language in question.

SElection is the active process by which the SENTence and the SITuation are associated. The SElection principle comes from hypothesis testing theory (Krechevsky, 1932) which is associated with cognitive psychology (Bandura, 1977; Piaget, 1926) and supported by recent research in system science (Buckley, 1968; Miller, J., 1978). Man is seen as an interactive organism which uses previously existing knowledge about the environment to make further guesses about it. Man then acts upon those guesses (hypotheses) to test them out. The action or behavior triggers feedback information which confirms or denies the hypothesis (guess). Learning is seen as a process of building up a more and more accurate, and more and more elaborate cognitive map in the head by checking it with reality.

In terms of language learning, this cognitive process seems to work as follows: First the learner hears various sounds and tries to associate them with a meaning. He will hear a SENTence and "guess" which SITuation it refers to. If the SENTence such as "Pick up the ball" is made in the presence of several objects such as "a toy car" "a baseball bat" and "a ball" the language learner must "guess both the action, and the object" from past experience. The learner makes a "guess" and picks up "the baseball bat". Feedback from the mother as she says "No, the ball, not the bat" corrects this wrong guess. The mother may even point to the ball to help the learner guess. This listening to an audio SENTence and SElecting from several alternative SITuations is the way, most of us learned our native language. It is also a powerful way to learn a second language. Harold Palmer has referred to this language teaching technique as "the imperative drill". (Palmer, 1925) James J. Asher calls it "the Total Physical Response" approach. (Asher, 1965) The more general model is: Given a sound SENTence, and

several alternative SITUations, the learner SELEcts one, and receives immediate feedback regarding the appropriateness of his SELEction.

One of the key ingredients to the SELEction process, is the feedback information which is generated. This must be very rapid, almost immediate (within 5 sec.) if it is to be of any benefit. When mothers talk and play with their children, they usually use short phrases and make the meaning quite clear, and then are very attentive to whether they are understood or not. Thus in home training, listening comprehension training, generally involves immediate feedback from the parent. In most classes with large numbers of people, this has not occurred, and as a result, listening comprehension has not been extensively developed. The Sens-it Cell Model examines this situation more precisely, and as a result, a number of practical applications for teaching listening comprehension have been developed.

The speaking process is viewed as the opposite of the listening process. When speaking, we first begin with the meaning, or the SITUation and SELEct from several alternative SENTences the one we guess to be appropriate. Then we say it and judge the reaction. If the child wants a glass of milk, but says, "Give me water" he will quickly realize, when given water, that he used the wrong SENTence, guess again, and speak again the new SENTence. In cognitive learning theory, it is not the practice of speaking which is important or influential so much as the feedback of correct response. When a baby is learning to speak, the correction by the mother, tends to be rather immediate, because they are in general paying close attention to each other. Correction of the older student's speech by teachers often appears both punishing and ineffective, because the feedback information is delayed. Feedback information must be immediate to be effective. The Sens-it Cell Model points out how correct listening skills, provide the best feedback mechanism for speech, through a self-monitoring speech

system. Native speakers learn their grammar as a "sounds right" phenomenon. (Burling, 1982) It now appears possible to develop this same internalized grammar phenomenon in second language teaching through application of the Sens-it Cell Model.

To summarize briefly, the Sens-it Cell Model as presently derived, indicates that students should be taught to comprehend a language aurally before they attempt to speak it. That comprehension involves the integration of a foreign sound SENTence and a meaningful SITuation. In order to achieve this comprehension most effectively, it is hypothesized that a student should be continually involved in active SElective processes which involve immediate feedback. Oral response or speaking should be delayed until this comprehension is comfortably fluent. Because this position was derived from a wide range of scientific disciplines beyond the normal reading level of linguistic and language professionals, it requires some additional theoretical explanation.

Theory has been a badly abused word. It has been misused so much that it is often today considered to be the antonym for practice. In referring back to the original Greek meaning, we find that the word theory comes from *theoros*, "spectator", from *theasthai*, "to observe, to watch, to look at", and from *thea*, "a viewing". The word theater is derived from the same origin. In this paper, theory is being used in this original sense, simply as a pointing or focusing device. Recent work in cybernetics has helped bring these two concepts together through the unifying concept of feedback. It is believed that theory, which simply means "where to look" guides practice, in the same way a thermostat guides the temperature in a house, through feedback.

The original synthesis of theory and practice, of perception and behavior, came from a group of scientists working on special weapons such as the homing torpedo during World War II. They used their knowledge of how the human body behaves in order to

develop weapons which could "think". That is, a homing torpedo can operate something like a thinking being and "track" a moving ship, even if that ship tries to get away from the torpedo. This is done through a process called feedback, and it led to the basic principles of cybernetics. (Wiener, 1948) An audiologist named Grant Fairbanks read about cybernetics and applied the principles to human speech. (Fairbanks, 1954) His work was not understood by the linguistic field and was ignored by the language community. It is however, one foundation upon which the Sens-it Cell Model is built, so it seems necessary to go into a rather extensive explanation of the feedback control concept.

The usual example of feedback control given is the thermostat. If the temperature goes down below a certain point, the thermostat "tells" the heating device to start, and when the temperature goes above a certain point, the thermostat signals the heating device to stop. A servomechanism, is a more complicated device which is used as a feedback control mechanism. This is what is used as a "cruise control" or speed regulating device in an automobile. While these devices are now common in engineering, it has only been recently recognized that this is the fundamental control mechanism of human behavior. (Powers, 1973) The human nervous system can *only* cause muscles to tense. Because any specific action requires the complex coordination of many muscles tensing and relaxing, a control mechanism has been sought. Feedback control appears to be the answer. (Adams, 1971)

The cybernetic scientists developed a new taxonomy of behavior, (Rosenblueth *et al.*, 1943) which first distinguished between active and passive behaviors. They defined passive behavior as that behavior which is caused by energy from outside the system. For example, a billiard ball will remain at rest until an outside force causes it to move, and then it will follow a certain trajectory. The energy came from outside the ball, and it follows the laws of motion

set out by Newton. Active behaviors on the other hand, are defined by Wiener and others as those in which the system in motion is the source of the energy, as with a homing torpedo which has its own energy supply. These objects according to these cybernetic scientists exhibit active behavior. Almost all animal behavior including human behavior is therefore considered active. An exception would be if a cat for example, is thrown by a human, we can not say that the behavioral trajectory of the cat is active behavior. In this case it is passive, and will follow the laws of physics. Physics, in fact, can be considered the study of passive behavior.

It should be noted at this point, that almost all human behavior is active behavior. While listening has often been referred to as "passive" behavior, it can be seen from this taxonomy that this is an inappropriate term. While an observer looking only at the surface of a listener may not see action, it is now clear from studies using instruments which read brain activity, that listening, like all human activities, is a very active process.

Active behavior, which all humans exhibit, was then divided into two sub categories: random, and purposeful. A drunk walking around and bumping into a lamp post is often described as exhibiting random behavior. This is because there is no way to predict its sequence. Purposeful behavior is predictable behavior. It generally is considered to involve a goal and movement to that goal. What appears to be random behavior and unpredictable to someone who does not know the goal, may upon definition of the goal, turn out to be predictable, and hence purposeful. To be able to make the shift from random to purposeful often simply requires the ability to shift one's point of view, to observe the complementary side of the behavior. For example, observing someone driving up a mountain road, and looking only at the steering wheel motion, one might conclude that this is random behavior. But if one observed the distance between the edge of the tire and the edge of the road,

one would be able to notice a great consistency, and hence imply purpose and predictability to this behavior.

The cybernetic scientists go on to subdivide purposeful behavior into two more categories, open-looped or programmed behavior and closed loop, or feedback behavior. Active purposeful programmed behavior is that behavior in which both all of the energy and all of the information are internal to the system. Clockworks were the first major mechanical device to exhibit this type of behavior. Mechanical toys which are designed to exhibit a certain set of behaviors, such as toy dogs which walk and bark are in this category. They are run by electric batteries and are controlled by internal mechanical devices.

Humans also seem to exhibit programmed behavior. Sometimes, our basic habits seem to be of this nature, when we simply repeat an action without thinking about it and without regard for the effect on the outside world. We often memorize poems in this way, each word triggering the next word in a chain-like reaction. Much of the "Audio-lingual" methodology seemed to involve this type of behavior. Students could repeat sentence patterns, often not knowing what they meant, or why they were being said, but just producing the sounds one after the other in a programmed manner. What has been referred to as rote memory, may well be simply this form of active, purposeful, programmed behavior.

Closed-loop feedback controlled behavior on the other hand, now seems to be by far, the most common form of human behavior control, and probably applies to language behavior as well. When a cat chases a mouse, he does not just set a program in motion, because the mouse will try to get away, that is, the mouse will try evasive tactics. In other words, the cat's environment will change, and he must therefore change his behavior in response to this change. Closed-loop feedback control takes in information from its environment and uses that to help control its next action. With

the cat and the mouse, the action and the feedback are so quick we often don't recognize its presence. The process also involves predictions about the future movements of the mouse, and feedback on whether that which was predicted (guessed) is actually happening. There is in effect a hierarchy of feedback loops which tend to control very complex behavior patterns.

This hierarchical model of feedback loops was first suggested to the field of psychology by a neurologist, Pribram and a Psychologist, Miller. (Miller, *et. al.*, 1960) They called the model, a TOTE model, TOTE stands for Test, Operate, Test, Exist. It refers to the use of the Test as a feedback sensor. For example, if one is hammering a nail, one first checks to see if it is still sticking out, or flush. If the "test" indicates it is still sticking out, then one Operates, or hammers the nail, then one Tests again to see if it is still out. One repeats the Operation, until the Test shows that the nail is flush and then one Exists to the next activity. The Operation phase however, is quickly found to contain within it, another TOTE. That is, when one decides to hammer, one must first TEST whether the hammer is up or down. If down, the OPERATE must be to raise or lift the head of the hammer. If the TEST shows the hammer head up, then the hammer head is OPERATED to move it down against the nail. The operation of striking the hammer down however also calls for another internal TOTE, for example, one must TEST for which muscles are relaxed and which are tense or contracted, etc. This analysis can also be extended in the other direction. For example, before deciding to hammer the nail at all, (OPERATE) one must TEST whether it is placed in the right place, whether a nail should be put in at all, and even whether the object should be built in the first place. Thus there are a series of decisions which need to be made, all of which require checks within the environment, and feedback information from the environment.

Most of these concepts were applied in Grant Fairbanks analysis of the speech mechanism of Man. He proposed a model of speech as a servomechanism, in which the speech was controlled through hierarchical feedback loops by hearing oneself speak. In other words, speech is an active, purposeful feedback controlled behavior. The basic TEST units are the various levels of listening comprehension anticipated by the speaker. The OPERATE units are the muscular contractions necessary for speech to occur. We speak in other words, in order to hear what we want to hear. Whenever we do not hear what we expect, we can correct ourselves. That is, when we have developed our language competency to a sufficient degree, that we know what we should be hearing is proper speech, then we can speak and correct our own speech through the feedback loop built into all of us. This was the basic model presented by Fairbanks, and he tested it, by a series of experiments in which he delayed the auditory feedback. (Fairbanks, 1955) When the feedback was delayed between 190 to 260 millisecc. (about the length of a syllable) the speaker's control of his own speech drastically and dramatically reduced. The speaker began to stutter, repeat himself, increase his volume, and in general become incoherent.

While these experiments in delayed auditory feedback provide some evidence for the existence of listening feedback control of speech, they also point to a feature of hierarchical feedback control not often recognized as critical in language teaching, i.e. the rate of language processing at the different levels. The delay of 190 to 260 milliseconds proved to be the most critical because it matched a particular muscular response, that is the syllable formation response time. But in any hierarchical order, it can be recognized that the responses at the lower levels must take place much more rapidly than those at a higher level. The lower levels operate at different time scales than the higher levels. It is highly likely that the phonetic analysis feedback loop takes place much more rapidly

than the lexical-semantic analysis; and word order analysis takes place at a slower pace than morphological analysis, and all of these take place more rapidly than the conscious understanding of the sentence as a whole. It may even be speculated that the concept of consciousness is simply that part of the feedback hierarchy which takes place at a certain rate of processing. The processing which is faster is referred to as "sub-conscious". This has serious implications for the teaching of grammar in a conscious manner, since it appears that most grammar feedback control TOTEs take place at a faster (sub-conscious) rate. This may also be why people who learn languages consciously at their own rate of processing, as in the translation method, have so much difficulty in listening to the language when it is expressed at a normal rate of speed.

The language teaching process has always been effected by the basic assumptions teachers have about certain critical aspects of that process, such as the nature of language itself, the nature of learning and the nature of teaching. Underlying everything is a kind of basic assumption about the nature of Man. Usually these assumptions are implicit rather than explicit, and they are often unrecognized as influential. There is, and has been a number of shifting assumptions about each of these areas during the past half century which have significant effects upon how languages should be taught in the future. The Sens-it Cell Model is an attempt to develop a theory of language instruction by making as many of these assumptions as explicit as possible.

Although some people have considered language primarily as a communications tool between people, and studied primarily that aspect which was publicly available, the Sens-it Cell Model was developed on the assumption that language take places primarily in the brain and that in interpersonal communications, only one aspect of the language is transferred. The terms SENtence and

SITUation were used to identify these two aspects. A SENTence can be passed between people, but it does not become a language until it becomes attached to something meaningful in an individual, a SITUation. The SENTence is like a key which is passed from person, but each person retains a SITUational lock in their own head, which the key opens if properly matched. Thus languages are primarily viewed as this fusion between SENTences and SITUations or SEN:SITs. Languages operate by a SELECTION process between the various SENTences and the various SITUations. Thus language processing is seen as a SENTence, SITUation SELECTION process or SEN:SIT:SEL. This expression was changed to Sens-it Cell to reflect the second basic assumption shift, that concerning the nature of behavioral control.

In early behavioral psychological theories, the behavior was considered to be important, and the practice of that behavior was considered to be very important. The expression, "learn by doing" was a reflection of this point of view. The Sens-it Cell Model however, is based upon the cognitive psychological principles which have come out of the field of cybernetics. This sees Man behaving, not as a consequence of S-R conditioning, but as a growing, self-organizing system which controls its behavior through a hierarchy of feedback loops. Language learning is thus seen as the growing of a language cognitive structure through the development of listening comprehension.

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