

## Information and Concept Formation

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Let us begin with two simple premises. First, what distinguishes the communication of information from other forms of communication is accountability, i.e. that it is required to communicate something specific: either a set of data or facts, or a specific frame for looking at data or facts. Second, that the communication of data and facts relies on frames for looking at them. Without a frame of reference, facts are meaningless. Often communicators can presume that competent receivers already have frames. For instance, for professional readers, a the presentation of a company's history of earnings growth and its current price earnings ratio will cue a frame of reference within which to look at the stock price. But, we can quickly imagine three scenarios in which the strict information display model is not adequate:

1. The frame of reference is in question or it is a problem. The information is an enigma that cannot be placed into the reader's known frames. The information needs a new frame of reference to make it intelligible.
2. The reader is not a professional, but a consumer who needs to be educated as well as informed.
3. The reader's arena of action is substantially separated from the frames that are applicable to the information. For example, the reader is presented information about a specific stock or sector, but he or she must make overall decisions about his or her portfolio or buying decisions as a consumer.

All of these scenarios have appeared as themes in this forum: new information requirements of changing markets, customization of information for consumers who are increasingly acting as their own fiduciaries, and particularly in terms of delivering information and providing information interfaces that are directly actionable. New approaches range from consolidated statements, to smart agents, and qualitative (low-resolution) displays. They bring us to an aspect of information design that complements the notion of

communication as information display or message: a **concept formation model of communication**.

The concept formation model of communication sees the communication not as the transmission of information, but as a series of challenges and resources that provoke and support cognitive processes of the receiver, including perception, thought, inference, recognition, and memory. This model complements information presentation or message approaches by concentrating on the receiver as the one who constructs the interpretive frame, and on cognitive processes. There is no avoiding information presentation; if nothing is presented there is nothing to think about. But, whatever is presented has to be processed in order to be received, and it will be received according to how it is processed.

The concept formation model recognizes the receiver as an active participant, but it balances this by recognizing the communication as an active participant as well. The communication is not merely a tool of the active receiver, but an interactive partner, indicating the situation, modeling roles by displaying comportment that is appropriate to the situation, and steering the receiver toward the frames it wishes the receiver to invoke. When we speak in terms of the document, we speak of its meaning, while when we speak of the reader's participation, we speak of interpretation. This model focuses on the reader's participation, and thus on interpretation. The two are complements.

The term "interpretation" can be taken in three ways: identification, meaning or implication, and evaluation. Of the three, identification is primary: it is who or what we are seeing or what we think is happening. Comprehension grows out of consideration of objects as identified, and evaluation is one's sense of the objects as related to one's goals and desires. While advertising often attempts to attach an evaluation to some object which is poorly if at all identified, the goal of information design is the opposite, to enable each reader to reach a clear understanding and on that basis to make his or her own decisions.

Primary interpretation (identification) is a highly objective and rational process. It is what keeps us from walking into doors and falling down stairs. Communicators count on the rationality and consistency of this process among receivers and thus on the ability to anticipate and accommodate it.

This paper presents the concept formation model through Ph.D. research conducted at the Institute of Design, Illinois Institute of Technology.<sup>1</sup> There are three fundamental aspects to that work (Figure 1). This paper will summarize some of the theory itself and some relevant experimental findings.

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<sup>1</sup> Storkerson, P. *Cross Mode Communication in Multimedia*. Chicago: Institute of Design, Illinois Institute of Technology. 2001, 169p.

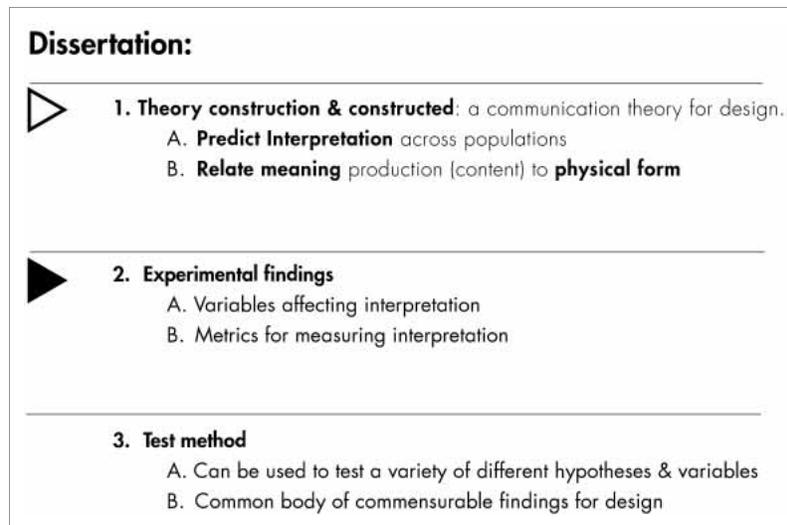


Figure 1: Cross Mode Communication in Multimedia, Major Sections

Basic tenets of the concept formation model are displayed in Figure 2. At the heart of the concept formation model is the notion that a receiver must, select or create a frame of reference to make a communication intelligible. That frame defines the communication's meaning or content, as distinct from its subject matter, and it is the primary communication goal or prerequisite. Again, noted by others in this forum, the subject matter may be the price of a car, while the content may be "What can I afford if I want to retire in comfort?"

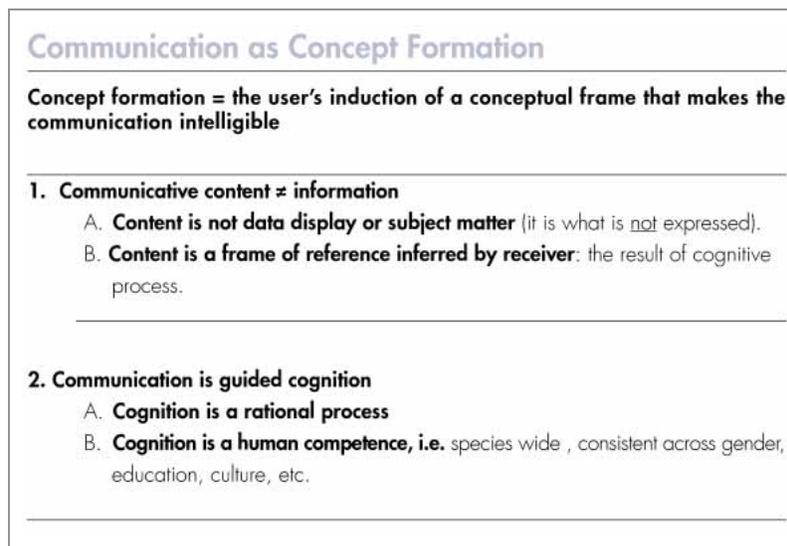
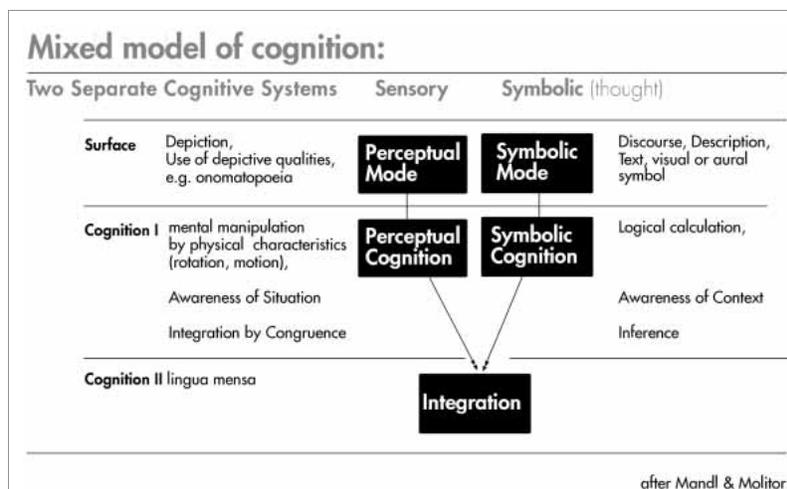


Figure 2: Concept Formation Model

Increasingly, communications combine symbolic modes such as language, with sensory modes: visualizations including charts and diagrams, sounds, motion, navigation, etc. In doing so, they mix two different cognitive systems. The distinction can be demon-

strated directly. Take the sentence "the house fell on my head" and ask how we make sense of it. In terms of word meanings, it is difficult to find linkages between "house" to "head" that specify their semantic relations, but it is very easy to make up a little imagined visualization, and watch the house lift up, rotate, turn upside down and fall on my head.<sup>2</sup>

Sensory systems operate according to experiential dimensions of time and space. They function narratively, like the house visualization, and are tied to specific events and locations. Sensory systems organize the flow of experience spontaneously, into the discrete events and entities of perception, and resolve them by coherence. Symbol systems are category driven. They require the naming of specific events and entities. They are not fundamentally tied to specific places and events. Symbol systems concentrate on a finite number of items calculating and inferring answers on the basis of reasons rather than some overall coherence (Figure 3). Finally, sensory modes give us experiential knowledge, which is incommensurable or qualitatively different from symbolic knowledge. The house visualization does not just give us more information about the sentence, it tells us what the sentence might "mean" in terms of experience.

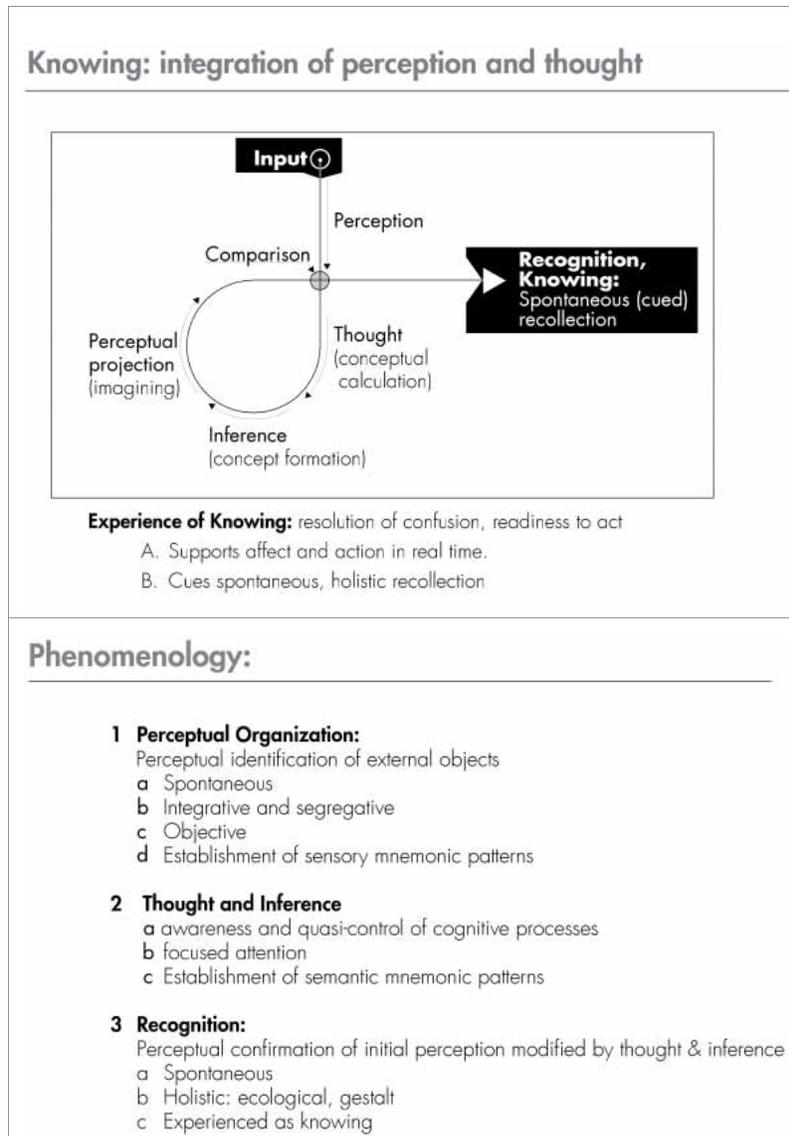


**Figure 3: Mixed Model of Cognition**

In graphic and multimedia communications, the symbolic and sensory modes must be integrated to give a single experiential-conceptual amalgam. It is this cognitive integration of two incommensurable systems that gives graphic communication its power. Cognitive processes combine perception and thought to form inferences, which are projected or imagined and compared with direct perception. When projected inferences and

<sup>2</sup> Waltz, D.L., "Toward a Detailed model of Processing for Language Describing the Physical World," Proceedings of the Seventh International Joint Conference on Artificial Intelligence, IJCAI-81, University of British Columbia, pp. 24-28, August, 1981

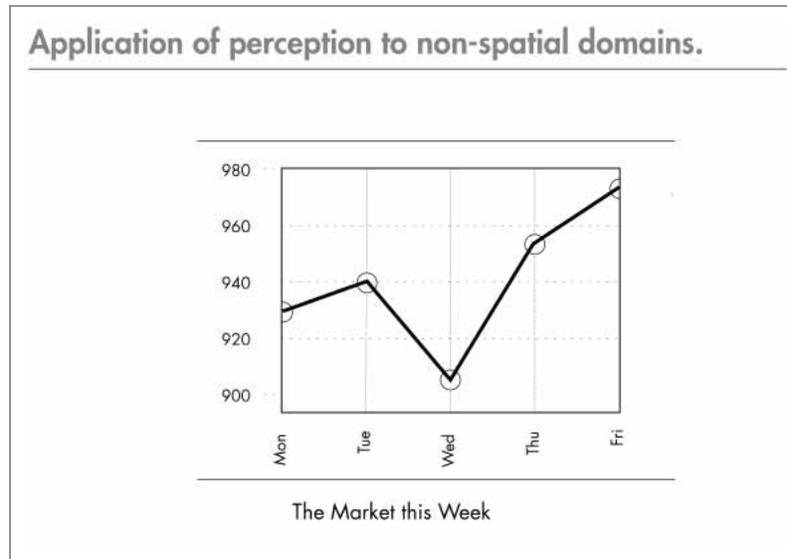
direct perceptions match, the result is recognition, which is a combination of sensory and conceptual elements resulting in a phenomenology or sense of knowing or grasping (Figure 4 a, b).



**Figure 4 a, b: Cognitive Process and Phenomenology**

For example, I meet someone new who looks vaguely familiar. I try to think of whom she looks like. I think of someone, visualize the person as of when I last saw her, and compare that image with the person in front of me. I recognize the resemblance and can see what it is, e.g., eyes or hair. Now memories of and feelings about that other person also enter my mind.

Graphic and multimedia communications harness the knowledge built into sensory cognition and apply it to other domains. A stock price graph relies on symbol systems to refer to days and to indices, but it is sensory cognition °© the ability to run movies in the head°© that is behind the implied motion of diagonal lines and that enables viewers to intuit that prices are moving up and down. Thus, graphic communications leverage sensory knowledge and use it to teach about other things, and to imply narratives (Figure 5).



**Figure 5: Graphical Sensory Cognition**

Image-text composites are even more fascinating (Figure 6). Imagine a photograph of a woman from the waist up. Her left arm is extended toward the camera and the hand is palm facing the camera, so that the torso and the face are obscured except for hair and sunglasses. By itself, this image has little meaning. Now, forget the image and consider the following sentence: °∞Joanne used the press as the press used Joanne.°± By itself, this sentence is enigmatic. When, however, the text is placed next to or over the image, the two are combined. Now, we have a new interpretive frame. It°Øs a picture of Joanne. We are looking through a picture taken by a press photographer whom Joanne is fending-off by shielding her face. She is a celebrity and the press are °∞using°± her by invading her privacy. But, if she is using the press, her pose is also ironic. She is both fending-off and attracting the press. She is negotiating her celebrity. As receivers, we cannot °∞know°± these things in the veridical sense of warranted proof °© the picture could be staged and the caption was certainly added °© but the combined image and text convey the meaning by supporting new interpretive frames and give us the phenomenology or sense of knowing what we are seeing.

Mixed sensory-symbolic presentations are all the more persuasive because we, as receivers, sense that we are making our own interpretations. Phenomenological knowing as

shown in figures 4, 5, and 6 is the primary goal of information design. This intuitive sense of grasping supports makes information actionable.



Figure 6: Image-Text Cross Mode Cognition

Once defined, cognitive processes and outputs can be measured as memory. Psychologists have demonstrated that memory is not a record of stimuli, but of cognitive work. We remember the things that we see as significant that have meaning. We remember them as we interpret them: in the forms of meaning they have for us. We do not, for example, remember noise and clutter; we do remember form and structure. Memory can be seen in three aspects: stable retention, comprehension which is the depth of processing that is reflected in the entities remembered, and interpretation which is the structure or organization of what is remembered (Figure 7).

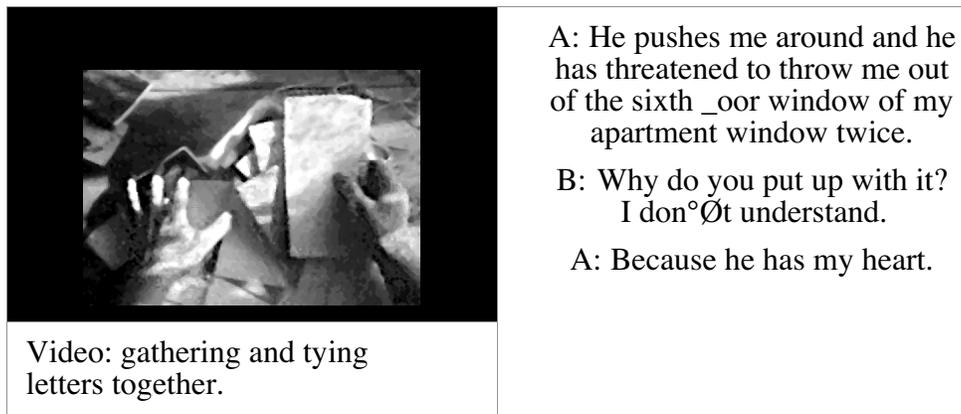
Cognition as Memory:	
<b>Integration:</b>	Primary cognitive act (phenomenological success) <ul style="list-style-type: none"> <li>• Identification</li> </ul>
<b>Retention:</b>	Long term memory (minutes or greater) <ul style="list-style-type: none"> <li>• Fact of memory</li> <li>• Stability of memory</li> </ul>
<b>Comprehension:</b>	Level of synthesis (method of memorial binding) <ul style="list-style-type: none"> <li>• Completeness of processing</li> </ul>
<b>Interpretation:</b>	Gestalt Integration perceived as identification <ul style="list-style-type: none"> <li>• Qualitative or "as" of memory</li> </ul> 3 types of interpretation <ol style="list-style-type: none"> <li>1. Identification (objective)</li> <li>2. Implication (according to a discourse)</li> <li>3. Evaluation (subjective)</li> </ol>

Figure 7: Cognition and Memory

Given that memory tracks cognitive work and its results, the primary cognitive act is integration, the organization of the perceptual field into distinct events and entities. Successful integration results in phenomenological knowing which can be measured as confidence (Figure 7). The cognitive work involved can be measured as processing time or latency. The primary record of cognitive process is long term retention: recall (Who was the president during the civil war?) or recognition (Who is in this picture?). Comprehension can be measured by the conceptual level of memory. Ericsson and Simon have

demonstrated that verbalizations are limited by the sophistication of comprehension.<sup>3</sup> Finally, interpretation can be measured as the selectivity of what is remembered and the structure of memory cues (what part reminds a reader of what other part).

If this model works, it can make a powerful claim that bridges from cognitive processes to interpretive content: if I know what you remember of a communication, I know how you can think about it, and by knowing how you can think about it, I know what you think. Experiments help determine whether these claims can be sustained. Two experiments were devised both used movies. Each movie was eight to twelve seconds long with a single event on video and a spoken text with a single statement or proposition (Figure 8).



**Figure 8: Experimental Movie**

In the first experiment, 40 movies were shown individually to 120 subjects, both male and female, from 18 to 60 years of age and with varying levels of education. After each movie, subjects were asked whether the video and words made sense together (yes or no). Then, subjects were asked how con\_dent they were of the response (Figure 9a). Records were made of responses and response times. From those responses, scores were constructed for each movie (Figure 9b).

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<sup>3</sup> Ericsson, K. A. Simon, H. Protocol Analysis: Verbal Reports as Data. Cambridge: MIT Press, 1996, pp. 1-10

### Movie Questions:

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<p style="text-align: center;"><b>Integration</b></p> <div style="display: flex; justify-content: space-around; margin-bottom: 5px;"> <div style="background-color: black; color: white; padding: 5px 10px; border: 1px solid black;">Yes</div> <div style="background-color: black; color: white; padding: 5px 10px; border: 1px solid black;">No</div> </div> <p style="text-align: center; font-size: small;">Do video and words make sense together?</p>	<p style="text-align: center;"><b>Confidence</b></p> <div style="display: flex; justify-content: space-around; margin-bottom: 5px;"> <div style="background-color: black; color: white; padding: 5px 10px; border: 1px solid black;">Low</div> <div style="background-color: black; color: white; padding: 5px 10px; border: 1px solid black;">Medium</div> <div style="background-color: black; color: white; padding: 5px 10px; border: 1px solid black;">High</div> </div> <p style="text-align: center; font-size: small;">How Confident are you of your judgment?</p>
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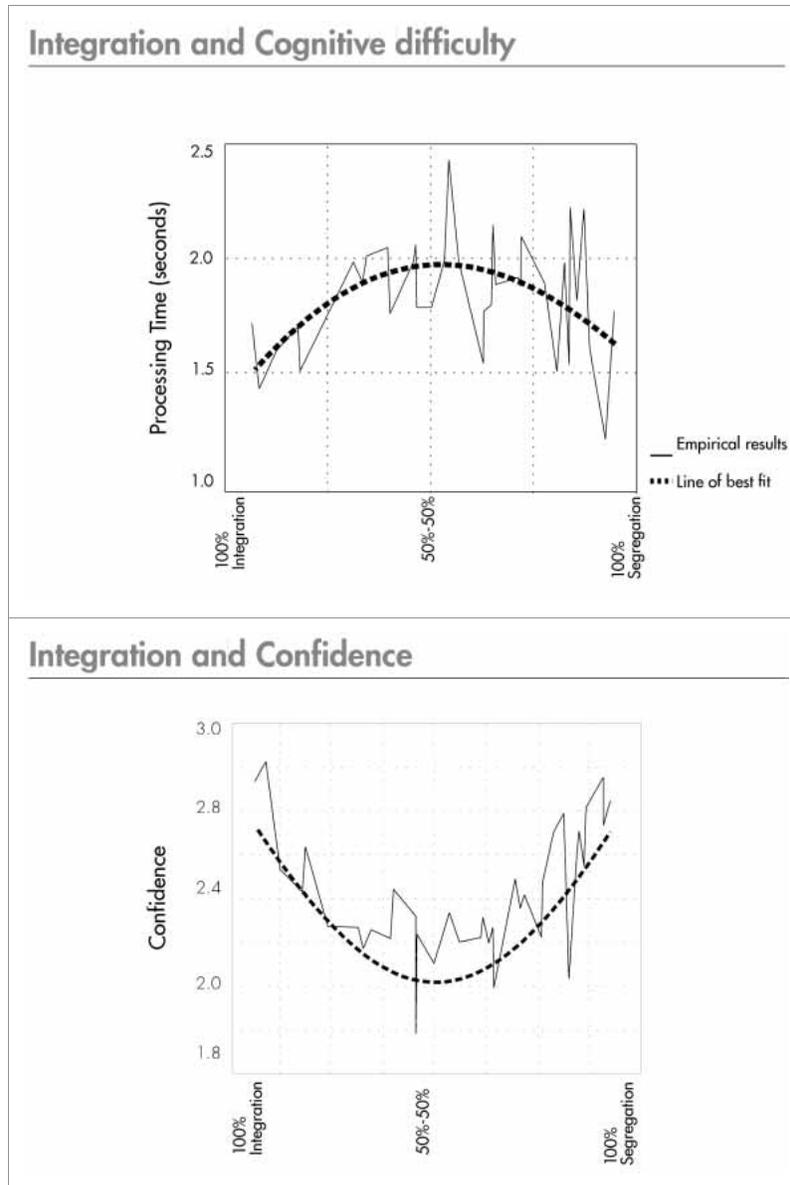
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### Movie Scores :

<b>Integration-Segregation</b>	% of subjects who integrated a movie Interval: from 1 (always integrated) to 2 (always segregated)
<b>Confidence:</b>	Mean of reported confidence for all subjects Interval: range from 1 (all subjects report low confidence)
<b>Integration Latency:</b>	Time interval between end of movie and Integration-segregation response Interval: milliseconds
<b>Confidence Latency:</b>	Time interval between Integration-segregation response and Confidence response Interval: milliseconds

**Figure 9 a,b: Movie Questions and Scores**

Figure 10 shows the important results. Movies ranged from those that almost all subjects integrated to those that almost all subjects segregated with many in between. Figure 10a shows that movies with the highest and lowest rates of integration were processed most quickly while those in the middle were processed most slowly. This indicates that in general, subjects found the movies with middle range scores to be more difficult to interpret. Figure 10b shows that subjects were also less confident of their responses for middle range movies. Subjects were forced to answer yes or no to integration (there was no "I don't know" option). They were, in effect, responding "If I have to choose, I will pick yes (or no) but it's a guess."



**Figure 10: Integration, Latency, and Confidence**

The relationship shown in Figure 10 are strong indicators of the measurability of cognitive functions. They also indicate the consistency of cognitive processes across a varied population (Figure 11).

Experiment 1 Conclusions :	
<b>Cognitive Processes:</b>	Processes are measurable and researchable
<b>Meaning &amp; Cognitive Processes:</b>	Inferences about semiosis can be drawn from the measurement of cognitive processes.
<b>Species-wide Competence:</b>	Cognitive processes underlie code systems, as a common competence.
<b>Narrative first:</b>	Movies are integrated first in terms of narrative and only later in conceptual terms.

Figure 11: Experiment 1, Conclusions

After all movies were shown, each subject was shown again ten of the movies he or she had integrated, and asked what made it possible to integrate the movie. The intention was to measure level of comprehension in terms of concept, but in almost all cases the response was narrative. For example, in the case of a movie like Figure 8, responses were of the form "He abused her so she dumped him." This is consistent with the notion that people integrate first according to a sensory scheme, developing conceptual analyses later (this indicates the mnemonic value of sensory schemes like visual structure and repetitions like rhymes).

In the second experiment, 20 movies from the first experiment were used but perceptual disturbances were introduced to one of the modes resulting in 9 delay states ranging from synchronized to a 1 second gap between the end of one mode and the beginning of the other, and with either video or text first (Figure 12).

Temporal Shifts	
<b>Delay:</b>	5 states
	0 = Synchronized
	1 = Video or spoken words delayed 1 sec.
	2 = Video or spoken words delayed for 1 sec. overlap
	3 = Video or spoken words delayed for no overlap
	4 = Video or spoken words delayed for 1 sec. gap
<b>Precedent:</b>	3 states
	0 = Synchronized
	1 = Video first
	2 = spoken words first

Figure 12: Delay States

As in the first experiment, after each movie, subjects were asked whether the video and words made sense together (yes or no) and were asked how confident they were of the response (Figure 9). After all the movies were shown, each movie was shown again as a memory quiz. For each movie, one mode was presented with the other mode taken from four movies including that same movie. Subjects were asked to match video and text that were originally shown together (Figure 13).

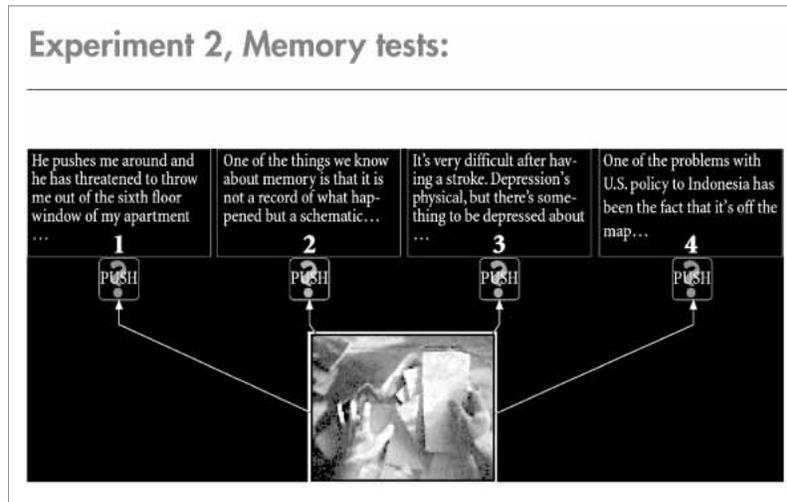


Figure 13: Memory Tests

As Figure 14 indicates, there were substantial relations between temporal shifts, integration and memory. Figure 14a shows that delays of as little as one second decreased integration. It did not matter whether video or words was first, indicating that neither was a primary carrier of meaning. Temporal delays reduced response latencies, even though they reduced integration. From this and other results, it was evident that subjects were trying to realign modes by memory as movies were playing. Once the delays were at or above the limits of sensory memory (about one second) processing should become very difficult, and subjects could be expected to abandon the effort. Interestingly responses were quickest where words preceded video (even though integration was unaffected). Because they are conceptual, symbolic systems suggest enframing more readily than sensory modes.

Most striking is the relationship between integration and memory. As Figure 14b shows, integrated movies were more remembered than those that were not integrated. This result is consistent with the hypothesis that we remember what we understand. Figure 14b also points toward a second factor beyond integration affecting memory: i.e. cognitive work itself. Research on "intrinsic interference and facilitation"<sup>4</sup> indicates that

<sup>4</sup> Battig, W. "Facilitation and Interference,"± Bilodeau, E. Acquisition of Skill. New York: Academic Press, 1966, p.213-241

Battig, W. "Intrinsic Interference as a Source of Facilitation in Transfer and Retention,"± Thompson, R., J. Voss. Topics in Learning and Performance. New York: Academic Press, 1972, pp.134-146

challenges like delays may inhibit or retard initial acquisition or integration, but it may also facilitate longer-term retention or memory. The results here suggest that while subjects may not be able to find conceptual or narrative linkages, they may find sensory patterns, which are themselves mnemonic.

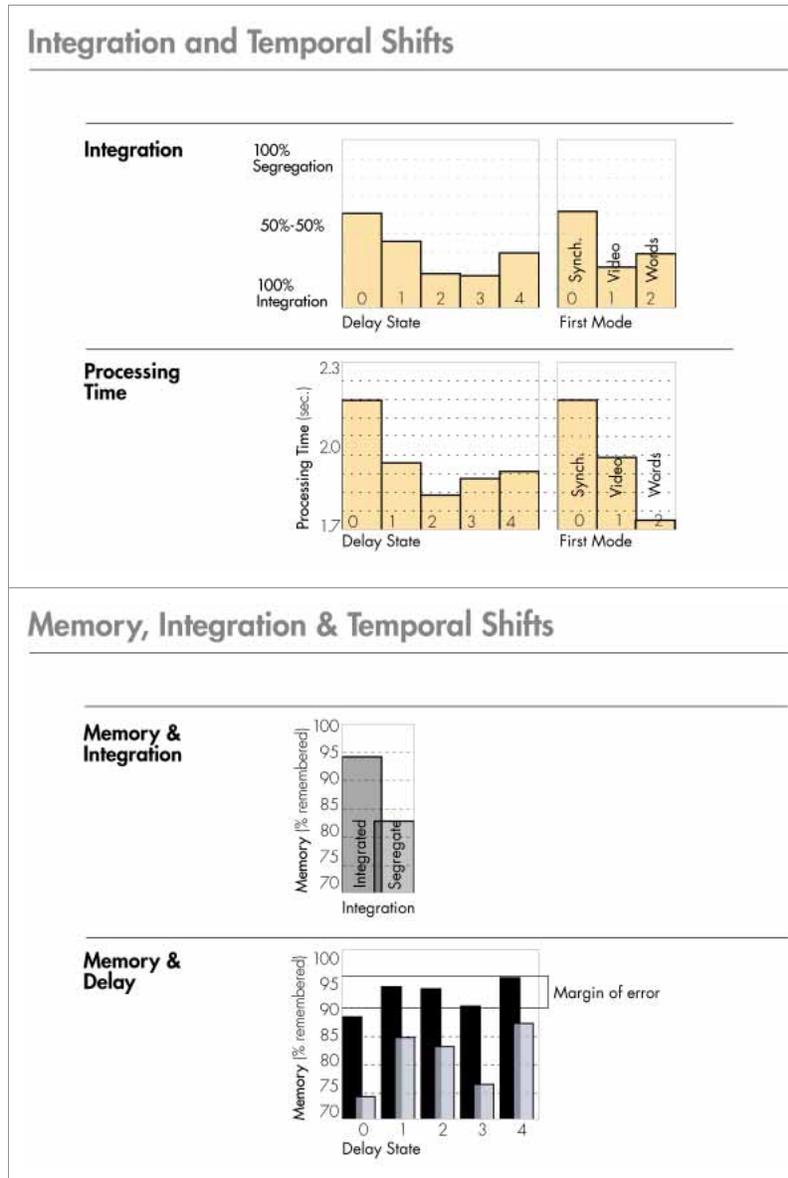


Figure 14a,b: Delay, Integration, and Memory

These are formative experiments initiating a larger research program which can include many other hypotheses and variables. Future studies will concentrate on the effects of sequence, and more developed memory tests.

Nevertheless, these experiments present a strong case for the validity, researchability and potential usefulness of the concept formation model. They demonstrate that cognitive processes are measurable and consistent across a broad population, and that they are related to primary interpretation (integration), phenomenological knowing (confidence) and memory (recognition). The use of time delays indicates the potential importance of sensory manipulations in the inhibition or facilitation of integration and memory as well as the organization of memory (interpretation).

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