CROSS MODE COMMUNICATION IN MULTIMEDIA

BY

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CHAPTER I

INTRODUCTION

This dissertation proposes a theory of communication based on human cognitive processes in relation to the spatial and temporal attributes of communications. The theory proposes basic variables to define human reception in relation to critical dimensions of the communication. It demonstrates experimental methods for testing its theory and for analyzing the performance of communications. The dissertation focuses on hypermedia as a form of communication that combines symbolic modes such as text with sensory modes such as image, movement, sound, and user interaction in the construction of the communication. Experiments manipulate communications by altering semantic and temporal relations between sensory and symbolic elements. They measure the effects of these manipulations on performance including the interpretation, comprehension, affective response, and memory of the communications.

Human Communication

The notion "communication" is a general one. It includes the transportation of both goods and information from one place to another and from one person to another. Human communication has aspects that set it apart from physical transportation:

1. Communication entails a special mode of apprehension. Receivers view phenomena as signs to be interpreted and they interact with them in terms of interpretation.
2. Any phenomenon can be apprehended as communication by a receiver and may be used as communication by a sender.

3. Communication is a method of social construction. Reports and representations are themselves interpretations. They are proposals that affect both human events, and their environments.
4. Communication is a reversible relationship between individuals; senders and receivers exchange places.
5. Communication is ubiquitous as a method by which persons come to common agreements, and by which knowledge and commitments are shared.

Communication as Social Action. Communication is best addressed by humanities rather than sciences. The human world is constructed by participants. Communication is a critical part of that constructive process. Communicative behaviors both reflect the understandings of senders and serve as attempts to reify those understandings by proposing them to receivers as grounds for action.

Communications are social and cultural methods of construction. Communications entail not cause and effect but cooperation, opposition, persuasion, and interactive turn taking or collaboration. They operate within settings of occasioned, practical action or endeavor, by supporting or guiding the flow of action or interrupting it in order to alter its future course. Communications are primarily methods not of explication or description as they would be in scientific endeavor, but of involvement and social action.[1] Finally, communications operate by affecting the internal organization of receivers through

[1] Elias, N., The Symbol Theory, Sage Publications, London, pp. 36-49, 1991

learning: i.e., cognitive change. Senders do not forcibly alter the behavior of receivers. They attempt to convince receivers to alter their own behavior.

Communication as Reception. The results of communications are dependent upon both what is sent and the responses elicited in individual receivers. Communications pass through the mediation of each receiver's cognitive faculties and processes, beliefs, and goals. Receivers are always active participants in reciprocation with senders and communications. They interpret communications: asserting beliefs about them, defining goals, and formulating strategies for operation with respect to them.

Communication as Cognitive Change. Communication involves learning: the self-reorganization or re-equilibration or "regulation"[2] of the receiver as the receiver assimilates and adapts to new experience. Learning is not merely the acquisition or processing of information. It is the result of a search for meaning which involves the mental remaking of the receiver who comes to a discovery or new understanding of the self, of experience, of an other, and/or of the relations between them.

Cognitive Entailments. A receiver uses previous knowledge and cognitive faculties to construct his/her interpretation of a communication. The cognitive faculties are comprised of a set of procedures: perception, conscious thinking, inferring and recognizing.

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[2] Piaget, J., The Equilibration of Cognitive Structures: The Central Problem of Intellectual Development, University of Chicago Press, Chicago, pp. 15-21, 1985

1. The receiver must identify the communication as a discrete entity with a credible, determinate structure. As a series of events, it must be identified (differentiated from other events in a receiver's environment and integrated) to be perceived as a distinct entity. For example, a communication must be identified as a communication.
2. Once it is identified, it must be recognized as having some content. The communication must have a meaning or relevance by which the receiver can relate it to actual or possible experience.
3. The receiver must experience the phenomenological sense of that understanding. He/she must sense the communication's "intelligibility" on some level. That level is the receiver's level of comprehension with respect to the communication.

Communication Theory

The major theoretical models of communication give important accounts of communicative goals, while their limitations point toward models that will be more suitable for design.

Three Models of Communication. Figure 1.1 provides an overview of three models underlying three types of communication theory. The type I model was originally intended for mechanical systems of transmission. Theories under this type disregard questions of interpretation or reception. The type II model is based on symbol processing.

Type II model theories include language and receiver based theories.[3] They link sender and receiver through culturally shared symbol systems. In this way they attempt to address the question of reception: meaning is to be found in the symbol systems themselves. The relationship between intended and received meaning depends on the common code system of a sender and a receiver, and the totality of their behavior as interpretable only within that system.

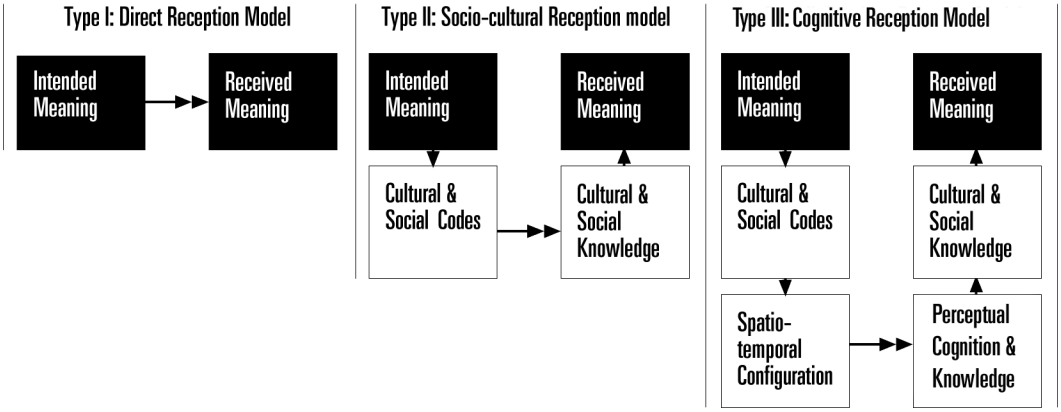

Figure 1.1. Three Models of Communication

In type II theories, the physical form of a communication is the enabling medium but it does not construct meaning. But, communication design manipulates physical forms to alter meaning. In communication design, particularly graphic design, the use of type II theories as guides for the analysis of communications results in the juxtaposition of, on the one hand, an explication of communicative objectives (norms of practice and

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[3] Fish, S.E., Is There a Text in this Class: the Authority of Interpretive Communities, Harvard University Press, Cambridge, 1980

appearance) against, on the other hand, a purely formal critique of the communication, which leaves a (cognitive) gap in the middle. Type II theories abound and despite their inadequacy for design purposes, they are often used by designers. As a result, in communication design, formal aesthetics are often proxies for communication goals.

Type III theories are concerned with the physical expression of a communication as its interface. They pay attention to the same issues as type I and type II theories but they are also concerned with the physical characteristics of communications with respect to cognition. They recognize that it is through the perception of the physical configuration of a communication that meaning is received. As with other human creations, the physical expressions of communications are not God-given but invented, so the relations between those physical expressions and meanings can be explored and altered. Perception processes external physical phenomena that are manipulated in design. It furnishes the materials to be read on both symbolic and sensory levels.

Although we identify objects by relying on the simultaneous use of both symbols and perceptual cognition, the two function differently. For example, if a lock is used as a visual symbol for involuntary restraint, it can function in a language like way. We know what a lock is and what it does. The lock can also function in a directly perceptual way, using perceptual cognition. We can perceive its closure, feel its weight, and imagine the difficulty of breaking it.

The recognition of symbolic forms is a matter of cultural knowledge and individual experience, while sensory cognition does not rely on cultural knowledge. We do not need

to know the symbolic meaning of a large object before we duck to avoid being hit by it. Basic cognitive procedures have consistency across individuals and cultures.

Diagrams, for instance, combine both symbolic and perceptual modes. Symbols point to referents while graphic arrangement indicates such relationships as linkage, containment and cause and effect or result. For example, in Figure 1.2, we see words and numbers arrayed and heavy dots centered on a line. These are symbolic forms. There are conventions of reading from left to right, and of any point on the line being the intersection of a vertical from the baseline and a horizontal from the vertical scale. The diagram also operates by gestalt phenomena of visual organization.[4] The implied movement of the line is along a perceptual dimension. It is visual, involving height, velocity, and gravity as they operate in the world. The graph harnesses sensory cognitive dimensions and uses conventional notations to tie data to referents in other domains.

Thus, the sensory cognitive resources that enable us to understand balls flying through the air and climbing hills help us understand line graphs and provoke us to ask about the early dip and spike in Figure 1.2 which stand as potential indicators of important underlying factors.

Because they are sensitive to the sensory domain, type III theories are needed in communication design. Type II theories remain valid and important, but they give us no

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[4] Sless, D., Learning and Visual Communication, John Wiley & Sons, New York, pp. 52-58, 1981

insight into the translation of communication goals into communications themselves. The receiver cognitively constructs the communication relying on cognitive procedures that are logically prior to the particular cultural codes in use at any time.

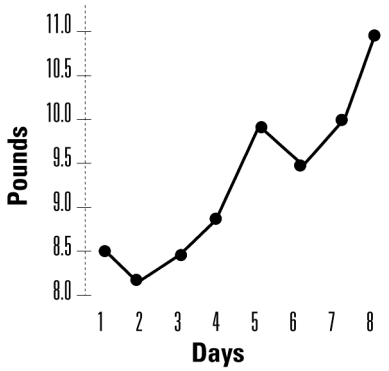

Figure 1.2. Infant Weight in the First Eight Days of Life

Approaches to communication which rely solely on culture-based analyses in the humanities leave a gap at the cognitive point of contact. There is a need for theories of communication that can operationally relate the social and cultural processes that are outside the individual to the cognitive processes that construct them in the individual. Type III theories can make type II theories believable by providing operational links between sender and receiver. They hold the promise of building a fully operational model of communication based on species wide faculties. The philosophical bases for such theories are to be found in theories of embodiment which relate thought to material existence. Varella and Maturana, for example, describe cognitive process as the interactive adapta-

tion of a living system to its environment.[5] Similarly, George Lakoff and Mark Johnson have jointly and individually elaborated a philosophy of embodied thinking to provide a "richer account of meaning and reason" than is available through rationalist and objectivist positions.[6] Neural psychologists such as Antonio Damassio model consciousness as the experience of self-regulation or equilibration in interaction with the environment: that our awareness of things always includes awareness of ourselves as experiencing them.[7]

Communication operates through symbolic contents and by the physical cognitive affordances it offers to the receiver who is searching for its meaning. The cognitive affordances, which interact with the receiver's cognitive faculties, make a communication's physical characteristics strategic and make a Type III model valuable. The receiver is a thinker, one who is in search of intelligible and credible interpretations of external reality. Intelligibility means logical coherence (it makes sense) for a receiver, credibility means reasonable accordance with other knowledge (it could well be true), and interpretation means perceiving "as": not just knowing that something is going on, but determining what it is that is going on.

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[5] Maturana, H., and Varela, F. J., Autopoesis and Cognition: the Realization of the Living, D. Reidel Publishing Company, Boston, pp. 13-14, 1980

[6] Johnson, M., The Body in the Mind: the Bodily Basis of Meaning, Imagination, and Reason, University of Chicago Press, Chicago, pp. 1-17, 1987

[7] Damasio, A., The Feeling of What Happens: Body and Emotion in the Making of Consciousness, Harcourt, Inc., New York, pp. 19-23, 1999

Communication: Experience, Rhetoric and Cognition. Communication is a rhetorical process of presentation and advocacy by which receivers are prompted to make cognitive adaptations: make discoveries, change minds, and have the sense of knowing. Rhetoric is unavoidable. If communication and learning take place in the world, they have to be spatially and temporally constructed and they must be as they are by virtue of how they are constructed. Rhetoric is a description of knowledge acquisition as it empirically occurs. Richard Lanigan, for example, describes the rhetoric of communication as speech that erects a perceivable cognitive object for speaker and listener.[8]

The creation of objects for consciousness (cognitive objects) is a matter of inducing in a receiver the phenomenological sense or experience of perceiving and knowing. Knowing is an experiential state of "I get it" in which the receiver's interpretive processes have been completed and satisfied by virtue of its settling on a cognitive object which has been successfully checked against experience, tested for its coherence, and tested in relation to a background of similarly tested and testable beliefs.[9]

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[8] Lanigan, R., Phenomenology of Communication: Merleau-Ponty's Thematics in Communication and Semiology, Duquesne University Press, Pittsburgh, p. 4, 1988

[9] In analytic philosophy, the notion of belief contrasts with that of true knowledge, as fallible v. infallible, but I intend it to refer to the discovery of a coherent viewpoint or notion which has its own internal integrity or validity and is sustained in the world by its relations to the web of entities that comprise the world we share (Willard Quine's "web of knowledge"). While for analytic philosophy, belief is fallible, from the perspective of this dissertation, it is prerequisite to all action. All action is according to something, and that thing has to have enough internal and external coherence to be actionable and testable.

The goal of rhetoric is knowing as a credible sense of real-ness or objectivity. Real-ness is more than a matter of the accuracy of information or functional confidence. It is the robustness of the cognitive object as understood in multiple situations that gives us our sense of knowing our view of it. Anthony Giddens[10] calls this faith and distinguishes it from expectation or confidence. Our confidence is in our sense of the likelihood that, for example, a particular elevator will work when we call it. Our faith is our implicit belief that we know what an elevator is. Contradiction in a matter of faith is far more serious than it is in a matter of confidence. A crisis of faith is not a disappointment in a particular object but a disorienting existential crisis of the interpreter.

Knowing is in the domain of experience, so experience cannot be bypassed. The domain of experience is different from the domain of scientific observation, not simply methodologically – recognizing the limitations of synthetic knowledge – but essentially. It is made up of different entities. Here, "…analysis (acta) focuses on conscious experience (capta) rather than on hypothetical constructs (data)…"[11] It is a hermeneutic universe in which:

> …Understanding…is possible neither by induction, …nor by deduction… Against these unidirectional models of scientific discovery, the hermeneutics propose an alternative model of understanding, not unrelated to the alternative which [Charles Saunders] Peirce introduced under the designation of abduction, the method of ex-

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[10] Giddens, A., The Consequences of Modernity, Stanford University Press, Stanford, California, 1990

[11] Lanigan, p. 5, 1988

> plaining data on the basis of assumptions and hypotheses about probable, not yet certain laws…[12]

The standard of phenomenological knowing or faith relates not to a single line of proof, but to a credibility based on multiple relations across multiple domains ultimately appealing to the coherence of a receiver's sense of the world as a whole.

The notion of rhetoric as credible construction is an old one. The Roman rhetorician Cicero uses the term "invention" to refer to the creation of cognitive objects. He describes it as a selection and arrangement of materials for an audience.[13] Invention forms the legitimate core of rhetoric. If rhetoric entails the selection and arrangement of materials to create new cognitive objects, then selection and arrangement may equally be viewed as rhetorical. Thus, communication design is legitimately viewed as rhetoric and its rhetorical core establishes its legitimacy.[14]

To summarize, communication is a rhetorical procedure that establishes:

1. Shared cognitive objects as agreements between senders and receivers on the identification and interpretation of those entities.

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[12] Nöth, W., A Handbook of Semiotics, Indiana University Press, Bloomington, Indiana, p. 336, 1990

[13] Cicero, "De Partitione Oratoria," De Oratore, Book III, Rackham, H., Tr., Harvard University Press, Cambridge, Massachusetts, p. 313, 1942

[14] See Ehses H., "Representing Macbeth: a Case Study in Visual Rhetoric," Margolin, V., Design Discourse, University of Chicago Press, Chicago, 187-199, 1989, or Tyler A., "Shaping belief: the Role of Audience in Visual Communication," Design Issues, Vol. IX (1), p 21-32, 1992

2. The meaning or relation of those objects to coordinated behavior or action.
3. Their meaning to individual persons, particularly receivers of the communication.

Rhetoric, Phenomenology, Embodiment and Knowing. In 1967 Robert Scott opened the modern discussion on rhetoric by arguing for rhetoric as epistemologically constitutive: "Insofar as we can say that there is truth in human affairs, it is in time; it can be the result of a process of interaction at a given moment. Thus rhetoric may be viewed not as a matter of giving effectiveness to truth but of creating it."[15] Rhetoric is not a fallible proxy for a more adequate epistemology such as analytic truth that operates by "giving effectiveness" to it. Rhetoric stands alone with its own self-sufficiency. Knowledge is created through rhetoric as the material process of communication. Even logical proof is a rhetorical method. Whether we communicate with others or within ourselves, the rhetorical process of communication is directly linked to thinking and knowing.

Support for notions of knowledge as embodied knowing based on interaction ranges from philosophy to neural science. The nominalist Nelson Goodman writes of perception as involving judgments of category: i.e., "representation as", as in a painting of Winston Churchill as a dog.[16] J.J. Gibson describes visual perception as ecological: i.e., the direct reception of objects with such object characteristics such as edge, surface, and

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[15] Scott, R.L., "On Viewing Rhetoric as Epistemic," The Central States Speech Journal, Central States Speech Association, Columbia, Missouri, VOL. 18, (1), p. 13, 1967

[16] Goodman, N., Languages of Art, Hackett Publishing Company, Indianapolis, Indiana, pp. 27-31, 1976

shape. Lakoff and Johnson describe language as growing out of "primary metaphors" which come directly from the same ecological level of physical experience.[17] Higher level thought is developed through the extension of these metaphors. For example, a notion such as "behind" which comes from visual perception is applied metaphorically as in the phrase "the thinking behind that conclusion".

Communication and Transmission. The notion of communication as it is popularly used implicitly distinguishes discovery of knowledge from the transmission of pre-existing information. Knowledge is transferred from one person to another by the communication – i.e., transmission – of information. This view is not supportable. First, it is not possible to make any radical separation between communications and other events; we interpret the communications we receive just as we interpret other events. We have to figure out, for example, that they are communications. Second, learning is not simply the retention of the words or diagrams used. Any tape recorder can repeat what is said to it. Learning entails the ability to appropriately use that which is communicated. Information is not passively received; its comprehension must be created anew in each receiver by that receiver through interpretation or knowing. Knowing is the ability to think about the information or with it. Thus, what we popularly think of as receiving knowledge is more like the guided discovery of knowledge.

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[17] See Lakoff, G., and Johnson, M., Philosophy in the Flesh, Basic Books, New York, pp. 26-27, 1999

Identification, Interpretation, Framing, and Naming. Interpretation is the production of frames or categories the receiver applies to make sense of those events and entities that comprise the communication. Interpretive framing may range from highly abstract concepts, to simple naming without much understanding, and finally to mere pattern recognition: the sense of a whole without the application of a category. Interpretive naming may be a routine choice for previously constructed concepts, or it may involve the construction of new concepts (concept formation).

The interpretive frame is a determinate interpretation or seeing "as" that enables the receiver to segregate and aggregate perceptions into discrete entities of experience: to isolate the communication from its environment and apprehend its structure. Thus, interpretation in its primary sense is identification or naming. The distinction between interpretation as identification and interpretation as evaluation is important. For example, compare "Here is what you are showing me," with "Here's what I think it means." The former is objective. It is about an object that exists in the world independent of our view of it. We attempt to produce the identification that is most appropriate to it, not to exercise our own fancy. The latter is subjective, at least for the time being. It is an opinion, or an assertion of our fancy. We know that we can be wrong about evaluations, at least until we are fully convinced of our judgments. Once we are fully convinced of a judgment, that judgment typically becomes reified, i.e., it takes on object status.

The identification of cognitive objects is the primary interpretive function by which we determine interpretive frames that define the boundaries and structures of objects and the discourses we apply to them. Identification cannot be avoided and must be carried out by each individual receiver. Its basis is cognitive: the inspection of elements as ini-

tially perceived and their aggregation into intelligible objects. Predefined code systems such as genres and styles direct that process at certain points toward established discourses (novels, sitcoms, ATM transactions). Still, within each genre, we need to use cognitive functions to individuate. For instance, once we are watching a sitcom, we are thinking about what is happening as it follows or breaks expected forms of its genre.

In common use, the term "interpretation" implies that phenomena may be interpreted in different ways by different persons. Such an approach tends to view the process of interpretation as inherently problematical, subjective, and evaluative. We think of one's interpretation of something as being different from the thing being interpreted. Such terms as "naming" stress the receiver's independent role in determining what an object is. The everyday identification of external objects also involves interpretation and naming, but we do not take this form of interpretation as subjective. Identification is our best effort to construct intelligible, credible and functionally reliable interpretations of that outside world. Interpretive processes represent individual adaptations to an independent external environment. The identification of an object entails having a determinate sense of its identity: not only <u>that</u> it is, but <u>what</u> it is. That identity is in the name used to refer to it.

Rhetoric as Cognitive Interface. Rhetoric functions as a cognitive interface between the content of a communication and the receiver as the thinker. A skillful sender guides the receiver by combining cues to interpretation: interpretive challenges and evidentiary resources to resolve the interpretive challenges. The meaning or content of a communication is constituted not by what is explicitly presented per se but by the interpretive frame or frames that can credibly be applied to it. Meaning or content is implic-

itly presented by the sender's selection and organization, and by the physical attributes of those things that are explicitly presented, as well as the strategic exclusion of other components.

Communication as a Social Activity. Participants engage in a dual activity of sending and receiving. As senders, we focus our communication on receivers and attempt to shape their interpretive processes. Senders influence the cognitive processes of receivers. Our competence as senders is built on our experience as receivers and on the guidance of more competent senders from whom we learn.[18] As senders we use empathy to anticipate our receivers and rhetorically shape communications to accommodate them. As we develop both individually and culturally, we come to differentiate communicative modes and develop rhetorics using particular symbolic systems and affordances that support specific cognitive access and methods.

Design: Publication and Face-to-Face Interaction

Publication is the distribution of communications beyond situations of face-to-face interaction. Publication, whether by print, video, or by other media, presents two major issues. First is the lack of effective feedback we find in face-to-face interaction. Second are the choices of media and the limitations and possibilities of each of them as mediators. These limitations compel designers to explicitly take problems of interpretation into account and construct methods for addressing them.

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[18] Vygotsky, L.S., Mind in Society; The Development of Higher Psychological Processes, Harvard University Press, Cambridge, Massachusetts, 1978

In individual face-to-face interactions participants alternate as senders and receivers, so the communication is subject to ongoing revision and repair. Outside of face-to-face situations as in books, films or hypermedia, the lack of feedback makes ad hoc clarifications or repairs impossible. Communication designers need to be able to predict their receivers and construct the contexts that will shape and repair reception. Designers are faced with two questions: "How can communications be made so that different people receive the desired content?" and "How do physical manipulations affect that reception?"

The code based answer is to define the domain of communication as a specifically public, cultural, and social domain—apart from private ones—into which individuals enter when they communicate.[19] Individuals place themselves in this domain when they communicate, and they interpret each other in terms of its rules. This public domain promotes interpretation by discrete paths of socially defined symbolic systems such as languages, communication types, and genres (the novel, the essay, etc.). These systems of communication function as institutions of expression, interpretation, and use. As communicative patterns, they represent social relationships between participants and support engagement in activities.

Cultural Systems for Interpretation. Designers invoke cultural systems by physical cues as indices of intended interpretation and of the activities and roles that are in play at any given time. Genre is a potent indicator of intention. Newspapers, for ex-

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[19] See Krippendorff, K., "A Recursive Theory of Communication," Crowley, D. J., Mitchell, D., Communication Theory Today, Stanford University Press, Stanford, California, pp. 78-104, 1994

ample, encapsulate a comprehensive set of communication patterns and attitudes about public and private life and the individual's participation in social life. We recognize a newspaper article by the layout, size, and binding of the newspaper itself, as well as the internal organization of its text, images, graphs, and so forth. Any and all observable aspects of communications serve as cues. These cues may be formally specified and applied like the German text often used in newspaper mastheads, or they may function well below conscious awareness like many conventions of conversation.

Most fundamental to hypermedia is the combined use of symbolic and sensory or "depictive" modes of communication. Each sense has its own particular characteristics and different symbol systems such as languages with different characteristics. The distinction between sensory and symbolic is overarching as it relates to the distinction between perception and conceptualization.

Sensory modes of apprehension are most closely tied to experience itself. Sensory modes of presentation can represent sensory events in their native modalities, while symbolic modes rely on description. Symbols make reference simultaneously to objects and to senses or discourses in terms of which they represent or interpret objects (Figure 1.3).[20] Thus, the interpretant or interpretation according to a discourse or frame entails a semantic aspect or characterization, and meaning is the relation of the concept to the discourse or its role in the possible events or outcomes that can take place within the dis-

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[20] Peirce, C.S., Collected Writings (8 Vols.), Hartshorne, C., Weiss, P., Burks, A.W., Harvard University Press, Cambridge, Massachusetts, 1958.

course. When applied to an object the discourse makes attributions, assigning its characteristics to the object. The totality of attributions, concepts, and meanings is the interpretation.

In principle, at least, sensory modes do not have to invoke discourses per se. They can make far more direct references which specify how those discourses are actually played out in experience. A picture can be worth 10, 000 words. By presenting symbolic linkages and apparent linkages to objects, they can be highly persuasive and believable: sensory data serves as proof of a symbolic interpretation.

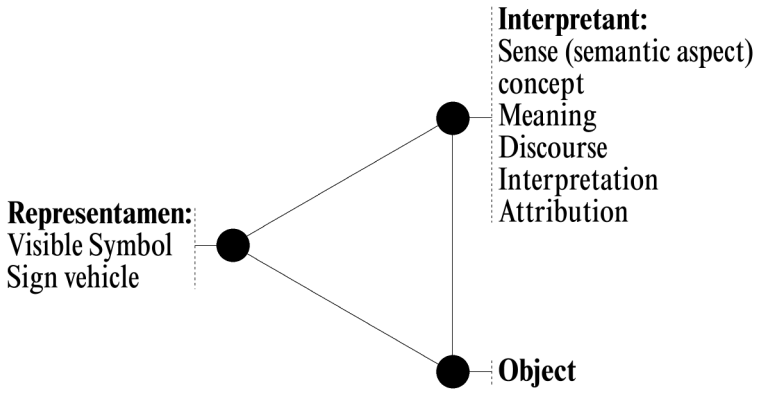

Figure 1.3. Semiotic Model of Signification

Within a symbolic system, there is no direct access to the physical object or to the domains of the object so there is ambiguity left by the translation. By combining symbolic and sensory modes, hypermedia can resolve the ambiguities, so we can know what a butterfly landing is really like. By presenting symbolic linkages and apparently linkages to objects, they can be highly persuasive and believable: sensory data serves as proof of a symbolic interpretation.

Single medium systems of communication, such as the text only document, place highly reductive constraints on communication. The reduction of a communication to a single mode requires highly organized and often formalized symbolic cues to signal genre (novel, newspaper photograph, comic book). By contrast, current multiple media communications often resist reductiveness, wishing to break with established genres. Hypermedia recombine reductive modes in what is sometimes referred to as "bricolage" or patchwork, requiring receivers to interpret across multiple symbolic systems. Chameleon like computer generated "virtual" media add another sensory layer of complexity by mimicking (perceived as being like but not being) familiar forms and environments, by morphing (freely transforming between unrelated forms), and by distorting objects that were here-to-fore stable.

Virtuality, the phenomenology of mimicry, i.e., being fictional, is characteristic of computer-generated hypermedia in both appearance and behavior. The notion of the screen and of computer representation as "metaphor" and the common usage of the term "metaphor" to refer to computer interfaces is a clear indicator of simulation as a way to invoke a cognitive category the way a stage set strives to indicate the location of a scene or like Nelson Goodman's notion of categorical perception as in his example of a painting of Winston Churchill as a dog.

Computer metaphors can act implicitly, below consciousness, in the organization of information, or they can act explicitly, explicitly proposing their metaphors as cognitive objects. For example, hypermedia and web pages exploit the book metaphor without really being books. Hypermedia also add interactivity, allowing for the potential repair and guidance of interpretation through turn taking. Interactive applications can model

or create situations in real time, giving the sender an unprecedented control over the receiver's experience.

Thus, hypermedia are new forms of communication which require the development of appropriate rules of operation. This breaking-out and transformation of traditional forms is an important aspect of the power of hypermedia. On the other side of this equation is the possibility that metaphors will fail, and receivers may not be able to gain access to content. This is common in hypermedia where users become "lost in hyperspace", where computer representations appear to be "fake", cheap imitations, or where the metaphors are distracting rather than supportive. Users may find themselves thinking about appearances, or navigational devices rather than communicative content.

One common reaction to problems of credibility in virtual presentation is to increase realism. The framing processes underlying perception indicate that the goal of realism should not be taken for granted. Simulation is not metaphor. Methods of presentation function by presenting cues and cognitive affordances supporting user attention and interpretation. Thus, metaphors may be most effective when used sparingly and strategically.

In short, methods of presentation are rhetorical tools: affordances supporting cognitive methods leading to interpretive frames. The perceptual credibility of a presentation will reflect its adequacy as a guide to appropriate interpretation. Presentations often look unconvincing not because they are too "unrealistic" but because they do not consistently cue an appropriate frame of interpretation.

Design Practice

To summarize, communication designers configure communications rhetorically by 1, anticipating the cognitive processes of third persons in different contexts, and 2, providing the means to guide receivers to construct the intended interpretations. Those means are often physical and function outside the domains of the content or subject matter of the communications.

The resources available to direct interpretation include symbols and sensory cognitive affordances. Symbols refer to symbol systems or discourses, while cognitive affordances support selective cognitive access or processing. The choice of communicative modes, organization, and sensory and behavioral cues affect the interpretation of communications, often without being recognized by the receiver as content related.

In designing hypermedia, traditional assumptions about interpretation should not be taken for granted. Physical aspects of presentation are strategic and should be evaluated according to their performance as reflected in the receiver's ability to interpret the communication.

Design and Communication

Communication design, particularly in hypermedia, lacks a theoretical base.

1. While there are theories discussing particular modes of communication such as film, image, literature, or scientific demonstration, there is little theory discussing the combining of different modes, such as the combining of text and image.
    a. Media based theories operate within one domain at a time, e.g., literary symbol in literature, etc. Design theory must operate across domains.

   b. Media based theories often syncretically combine characteristics of perception and reasoning, culture, social system, genre code, and specific sorts of knowledge. They lack the clarity needed at the anatomical level of discussion.

2. There is relatively little literature about human-computer interaction as related to the production of meaning.

Communication designers need theoretical models that can clarify communication goals, human responses, and material manipulations in operational ways. Functions that have to be addressed by any appropriate theoretical model include the following:

1. Define the goals of communications:
   a. What it is that one is actually attempting to communicate.
   b. What can be communicated.
   c. What a communication can accomplish in the receiver.
2. Relate communication goals to material structures: the choices that designers make, out of which ostensive communications are constructed.
3. Construct methods of measurement that can indicate the performance of communications: their reception and the representation of material structures in ways that can be examined and measured.

In particular, designers need a theoretical base for mixed mode communication including image-text and hypermedia. This theoretical base should be general and flexible enough to support further development of theory in mixed mode communication.

CHAPTER II

THEORETICAL POSITION

Neither message nor code based theories provide tools for clarifying communication processes. If there is no one language or sign system that all human beings use, the idea of a common set of methods or procedures may enable us to understand how human beings communicate. Cognitive procedures are promising in this respect. Cognitive psychology will be used in this dissertation to provide the missing operational base linking meaning and physical expression.

First, cognitive procedures have priority over the codes they produce. The use of codes requires a "competence" or innate ability to produce them. Once such a competence is asserted, specific codes can serve as indicators of underlying processes, which, unlike the codes themselves, are not learned or arbitrarily fixed, but grounded in human faculties. In this dissertation, communicative competence is based on the assertion that humans think in basically the same ways and that commonality enables them to learn and communicate with each other.

Second, the modes of communication are of two types: symbolic and sensory. If the meaning is independent of the appearance, but based on a learned code system, it is symbolic. If the sensory aspects are directly relevant to the domain of interpretation, it is sensory. This is not a matter of form, but a matter of use that is reflected in forms. One possible archetype for purely sensory communication would be the sudden noise of something happening nearby to which we react before we know what it is. The archetype

of symbolic communication is text, but insofar as the appearance of the text is relevant to the construction of meaning, it is visual, thus sensory. By the same token visual and aural communications are sensory, but when spoken text is interpreted without reference to the qualities of presentation, it is symbolic communication. Insofar as human perception is ecological, i.e., on the level of objects rather than sensations, the things we perceive have both symbolic and sensory aspects. Thus, it is indeed possible for any one item to operate on both levels simultaneously.

This view is at odds with those who argue for a fundamentally linguistic understanding of cognition, as with theories based on mode such as Lessing's opposition of literature against painting as a contrast between time and space,[21] or of sense organ e.g., eye v. ear. Differences between sensory modes are extremely important, but they are not the most fundamental. The symbol-sensory distinction is primary. This distinction also resonates with and helps to ground and clarify positions of others like Ernst Gombrich who work on understanding the text-picture difference.[22]

Third, cognition develops as a mode of action and reaction in a material world. That ecological level is the fundamental level of intelligibility. Sensory modes can deliver the

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[21] Lessing, E., Laocoon: As Essay Upon the Limits of Poetry and Painting (1766), Frothingham, E., tr., Farrar, Strauss and Giroux, New York, p. 91 quoted in Mitchell, W.T.J., Iconology: Image, Text, Ideology, The University of Chicago Press, Chicago, p. 95, 1986

[22] Mitchell, W.T.J., Iconology: Image, Text, Ideology, The University of Chicago Press, Chicago, pp. 75-94, 1986

outside world at that level of concrete or literal experience: the perceived, embodied world of everyday objects and actions. Because sensory modes can operate literally, they can present information at a level that is beneath that of symbolic communication. Thus, sensory communications are qualitatively different from symbolic ones.

By dividing communication in this way and analyzing perceptual cognitive methods, we can solve some of the mysteries about the relations between sensory and symbolic communication, and discover the commensurabilities between theories in Humanities, Sciences and Philosophy which interact at the nexus of communication.

Communication and Cognitive Processes. Cognitive processes are methods of adaptation that connect us to a common experience of external reality. These learning processes form the basis of communication. To be human is, by definition, to share the same environment as other humans, according to the same sensory dimensions and with the same set of associated cognitive processes. We share cognitive processes of perception, thought, and action. Each of us has individual experiences, beliefs, agendas, etc but even so we are able to communicate with each other. Certainly, each of us is dependent on his or her current state of knowledge to understand experience. But more fundamental than experiences are the cognitive procedures that make experiences perceivable. These are relatively consistent across individuals. Where one or a set of processes is different, we perceive individuals as lacking in basic competence.

This is an action oriented, constructivist position which argues:

1. There is an outside world which each individual accesses on the level of physical interaction.

2. That world exists for each individual mirroring the individual's adaptation to something external, and "objective."
3. Interpretation is the individual's access to the outside world: an integral part of adaptation.
4. Individuals share common modes of adaptation, so they share cognitive methods for interpretation, which enable communication and shared interpretation.
5. The code systems and meanings are higher-level knowledge and codes are social and cultural institutions that exist only through repeated enactment. Like contents, they change with learning, while the underlying cognitive processes, like containers persist as they are filled with new contents.

Metaphor and Cognition. As a corollary, the more communications engage receivers on the level of cognitive process rather than according to particular facts, the more consistent are the interpretations of those communications across a wide population of receivers.

According to material constructivists such as George Lakoff and Mark Johnson, most thought is metaphorical. As the basis for higher-level cognition, perception takes place at the ecological level of physical experience and action. Because physical experience is primary, that physical world of perception and action is "literal" to experience, so there are literal statements such as "this box is big." But, statements such as "this is a big problem" are metaphorical.

These base metaphors are not essentially about resemblance. They are calls to our basic ways of thinking about things: systems of structural relations that express our basic

perceptual and motional cognitive procedures. As calls, metaphors propose ways of thinking in specific situations. Through entailments, metaphors shape how we think about things. Such entailments construct gestalts.

We construct the world by acting according to our metaphors. The notion of containment, for instance, has entailments including an inside, an outside, a depth, a size, e.g., in trouble, in deep trouble, out of trouble, out of school. The metaphor of time as a resource which is embedded in such notions as "having enough time" has led to proposed legislation to prosecute on-the-job laziness specifically as theft. Could the refusal to work be prosecuted as robbery?[23] Metaphors are powerfully operative and practically unavoidable. They are not primarily linguistic entities but cognitive ones which form bases for language and other behaviors. Rhetoric centers on metaphors: proposing them and comparing them in terms of adequacy and their implications for coordinating human behavior in social construction.

The Role of Perceptual Modes. Perceptual modes can represent experience at a literal rather than metaphorical level. For this reason, they provide cognitive resources not directly available via symbolic modes. First, perceptual modes provide their own ways of thinking. Second, in perceptual modes interpretation occurs automatically. David Waltz

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[23] Lakoff, G., Johnson, M., Philosophy in the Flesh, p. 166

describes this using the sentence "My Dachshund bit our mailman on the ear."[24] A language-based approach to interpretation, i.e. one arrived at by analyzing the words like "dog" and "man" and the syntax, is extremely complex. We have to know what a mailman is and what a Dachshund is but that knowledge level does not resolve the puzzle. A language based analysis would be quite difficult if at all possible, but we quickly grasp the sentence if we imagine the event perceptually as if it were a video in the head. Visual entailments such as the height of the mailman and the size of the dog resolve the interpretation. When ambiguities interfere with the process of imagining, the interpretive questions appear in front of us. How could a Dachshund bite a man on the ear? Did the mailman fall? Was he a midget?

Perceptual modes anchor language to the phenomenological domain, i.e. to experience. In the sentence " My Dachshund bit our mailman on the ear", we have to know what a mailman is and what a dachshund is but that knowledge level does not resolve the puzzle. Language can cue perceptual memory and imagination (the speculative manipulation according to visual perception), but it is the memory and cognitive faculties that do the work and provide the sense of experiential grounding. In hypermedia, perceptual presentation provides such grounding. Thus, for example, we can understand abstract mathematics through animated diagrams.

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[24] 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

John Sowa makes a similar case. Here, though, the method of communication is linguistic, the indications are that the information is not stored in the form of language. Rather language cues perceptual processes.

> Instead of proving theorems, people assimilate separate facts into a coherent image. In psychological tests, Bransford and Franks (1971) gave subjects a list of separate sentences like the following:
>
> a. The rock rolled down the mountain.
> b. The rock crushed the hut.
> c. The hut was tiny.
>
> d. The hut was at the edge of the woods.
>
> After hearing these sentences, the subjects could not remember whether they heard the facts in a series of simple sentences or in a single sentence, The rock that rolled down the mountain crushed the tiny hut at the edge of the woods. When a new sentence, The hut was at the top of the mountain, is added to the list, people immediately "see" the contradiction: the hut had to be where the rock was rolling, at or near the bottom of the mountain. Although people differ widely in how graphically they imagine the situation, they normally detect the contradiction as if they were looking at a model or picture.[25]

Summary. So far, I have outlined the problem of understanding communication as "How knowledge is transmitted and grasped in the world, between and by individuals operating in space, time, social and cultural domains." I have forwarded a critical constructivism as a method of approaching the question and of showing how communication might work. By relying on a base of cognitive processes for communication, I have avoided the "one true world" problems of resemblance notions of representation. I have also avoided the problem of communication across boundaries posed by those that are

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[25] Sowa, J., Conceptual Structures: Information Processing in Mind and Machine, Addison-Wesley, Reading, Massachusetts, p. 19, 1984

based on the specificities of culture, knowledge and individual experience. Finally, I have argued for the distinctness and complementarity of symbolic and sensory modes of cognition.

This theoretical grounding is critical to establish a notion of communication that has the following specifications:

1. It is recognizable in terms of how people actually use communication.
2. It is credible in terms of what it says communication can accomplish.
3. Its theoretical grounding supports testing and measurement.

Operationalizing Concepts

Cognitive psychology will be used to operationalize the theory into hypotheses that can be clearly expressed. These will serve as the bases for operational hypotheses and variables to be tested.

In particular, the idea of "cognitive process" mitigates the problem of individual interpretation. It will also enable us to attack the measuring interpretation by measuring cognitive process rather than output. It also provides a link from meaning through semiotic codes to its "literal" physical expression. Such an approach is highly effective in design since the document is the only link, not only between the receiver and the sender, but the receiver and the meaning conveyed.

Operationalizing Reception. Reception is comprised of how we define and can think about the perceived thing: what it includes and excludes, and the relations or structure that comprise it. We can only think about things that we remember, and we

build meanings from associations among those things that we remember. Thus reception is defined as retention, comprehension, and interpretation:

1. Retention is stable long-term memory, as the recollection of events, as recognition of events from the past when they are presented, or as the retention of an acquired skill whether there is a memory of acquisition or not.
2. Interpretation is the configuration of associations or linkages of things remembered to each other: the being remembered "as". The configuration of memory reflects processes of integration and segregation by which cognitive objects are apprehended.
3. Comprehension is the cognitive level of concept formation binding the memory: the ability to think with and about that which is remembered.

These three occur together in any memory and they are interrelated as separable elements of a common structure.

Operationalizing Interpretation. Judgments and interpretations about things occur to us at high levels of synthesis: understanding what a movie is about or being convinced of an argument. For the purposes of communication design, we must be able to relate high level judgments and interpretations to low level decisions such as the use of colors, specific images, sequences and timings, which appear to receivers to be in different domains from the interpretations. In order to operationalize meaning in terms of material characteristics, I am using the following reasoning to establish the temporal and spatial characteristics of knowledge:

1. Rhetoric as epistemic: the structure of argument is the model of convincing others, and of questioning and deciding for ourselves. Invention in particular, which describes the process by which cognitive objects are created and transformed in argu-

mentation, also demonstrates the psychological process of concept formation as it appears phenomenologically to participants.[26]

2. Narrative and theory as rhetorical structures: knowing as the flow of events in time and as the semantic links that enable us to redirect events.
3. Constructivist epistemology: procedures and methods of cognitive systems.
4. Cognitive psychology: the empirical operation of cognitive systems in interpretation.

Each successive element of the chain operationalizes the notion of interpretation from its vernacular sense to a set of procedures describing perception, intellection, memory and recognition, moving toward knowledge as the experience or phenomenology of "knowing:" "what can be known, what it is to know or make sense of something, and how a thing is to be presented if it is to be known."

Within the domain of human experience, the notions of truth and proof as the physical sciences determine it, and "belief" as the fallible empirical substitute, are replaced by knowing and functional success. Knowing is an experiential state of "I get it" in which the interpretive process has been completed and satisfied by virtue of its settling on a cognitive object which is inspected for coherence and relation to the world. The measure of a thing is one's ability to test and verify it and use it effectively: its coherence and functional relation to a background of similarly tested and testable beliefs. For example, automobiles are real: they are independent of us (we adjust our beliefs to observations), and they do

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[26] Invention, the second of the five parts of rhetoric refers to the presentation of an object, its analytic dissection and reintegration into a new object. It is the heart of the rational structure of a rhetorical presentation. It creates the object under consideration while other parts concern the qualities and types of arguments establishing or refuting it.

what we expect them to do. Are they "true?" The notion seems hardly relevant. Automobiles are human designs.

This distinction between human and scientific: the phenomenologically real and the analytically true has corollaries:

1. Reality is constantly changeable. The first step in interpretation is the fixing of some cognitive object which is to be verified. That cognitive object is not inherent in the world but is posited by the human viewer: the aggregation of stimuli into collections that appear as plausible objects, e.g. the stove or the book. As we learn, our repertory of cognitive objects grows and changes, as the stove becomes gas or electric and the book becomes novel or poetry, etc.
2. Reality is action oriented. In a Platonist's "realm of ideas" truths are already fixed in essential structures and we ask if we have found them, but if knowledge develops out of human endeavor in a material and empirical world, we also form or fix the things that we examine. Nowhere is this arguably truer than in communication where we offer interpretations that we proceed to realize through subsequent behavior.[27]
3. Truth often stands in opposition to appearance, while in reality, credibility and validity cannot be separated from appearance: the appearances of things are real, and we can only inspect according to appearances. "Essences" are non-material noetic entities. Falsehood is the inconsistency of appearances upon inspection. Thus, we still have objectivity as the satisfactory integration of all that can be observed or dis-

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[27] See Berger, P., Luckman, T., The Social Construction of Reality: a Treatise in the Sociology of Knowledge, Doubleday, Garden City, New York, 1966.

covered about something under a frame of reference that is our conception of the thing about which things are known.

4. Truthfulness may be about a state of something in the past while realty may be about what something does in the present. The truthfulness, for example of a photograph, may be pegged to whether photograph x (a portrait), is actually of a particular person at some point in the past, while the reality of that portrait is a matter of its credible existence in this world and how it shape our view of it.
5. Reality is best presented in sensory modes of communication while truth is more directly asserted in language. Sensory modes present things while language makes determinate attributions that tell us what the things are. When we look at an object we search for a label that fits. We see the object as the label that fits. For instance, an object looks like a cup. On closer inspection, it is solid so it is unable to hold water. It is, perhaps, a sculpture of a cup. The notion of truth or falsehood is in the verbal assertion that it is a "cup."
6. Realities are rarely "erased" from memory as falsehoods. This is not to deny that sensory codes can mislead, but the modification of an interpretation after further inspection does not falsify or remove earlier experience. The statement "it is a cup" may be wrong, but its looking like a cup is not. Even where photographs "lie," as when persons are removed from group shots, the lies are not in the images, but in attribution. We see what we see but what we see no longer corresponds to an actuality.

Knowledge is by definition veridical while knowing is phenomenological. The distinction between knowledge and knowing is critical to the approach of this dissertation. In the domain of experience, "knowing" what something is, is an internal or psychological

state in which the thing appears to us with a determinate form so that we can know "it." We tend to perceive this as an external and objective process, i.e. not inventing the things around us, but discovering them.

Rhetoric and Knowing. The charge that rhetoric is a matter of persuasion and deception has prima facie validity, especially when it can be shown that expressions can affect interpretations across domains. At the heart of a rhetorical theory of knowledge are the notions that:

1. Rhetoric is inevitable in any real world presentation. This follows from the position I have taken, i.e. that knowing is a phenomenological state. Rhetoric concerns the methods by which the state of knowing is achieved.
2. Without reference to human action or sensory relevance, a communication cannot be intelligible. Intelligibility entails realness, i.e. a settled upon cognitive object which itself entails a form that can be grasped in the dimensions of time and space.[28]

Argumentation as understood by rhetoric mirrors the individual thought processes by which we form understandings and beliefs.[29]

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[28] Psychologist Lev Vygotsky proposed the dichotomy of everyday objects which have no clearly boundaries (where is the demarcation between a chair and a couch) and scientific objects which have distinct boundaries (the number "3"). The problem with everyday objects is to define them, while the problem of scientific objects is to find unequivocal expressions of them in the world.

[29] Robert Scott opened the current discussion of the epistemological status of rhetoric by arguing that if inquiry takes place in the world of experience, It must have a spatial and temporal expression. Rhetoric is that expression and the standard of rhetorical argumentation adequate to human fact finding.

The criticisms against rhetoric can be responded to as follows:

1. Any presentation in time and space will have its own structure and that structure will characterize its subject matter in particular ways both qualitatively (by naming) and by emphasis, de-emphasis, and associative integration and segregation.
2. The experience of objects in the world is embedded in thinking and language, but if something really has no sensory or experiential aspects, it is not possible to imagine what it is or that it is. Once an entity enters language, it is discussed in terms that are themselves rooted in human experience: sensory and behavioral.
3. At the heart of classical rhetoric is "invenio": invention or discovery. It is the presentation of some object, which is then examined by all possible means. The goal of examination is the surest knowing: factual, ethical, and practical.

Critical Constructivism. The position taken here is often called "critical constructivism." Radical constructivism posits that all experiences are the constructs of experiencing organisms themselves and that these constructions can be seen without reference to a common external reality. As such, they are subjective. Critical constructivism asserts that although experience is interpretively constructed (labeled) by cognitive organisms, there is a common external reality to be interpreted. Critical constructivism presents a middle ground between radical constructivism and more traditional "truth" based theories.

Within critical constructivism, the world as we see it is the one constructed first by the mechanics of our senses then by methods of perceptual and intellectual reasoning with reference to current knowledge. In contrast to "resemblance" theories of perception, for example, which would argue that mental representations have resemblances to the

things they represent, the position taken here is that any resemblance between neural patterns and, let's say a tree is very distant indeed. They are incommensurable. We are sensing our own internal states as they are altered by our interaction with the outside. Our knowledge or cognitive growth is the result of ongoing adaptation to the perturbations that result from contact with the external world. Cognitive growth is adaptation that moves in the direction of increasing the coherence and synthetic integration of experience.[30]

Just as the body can be seen as a historical record of physical adaptations to past environments, memory, and knowledge are records of past cognitive adaptations. The state of knowledge reflects ongoing attempts to reduce inconsistencies and to make experience comprehensible by integrating multiple entities into smaller numbers of more complex ones.

Current knowledge is made up of determinate formulations (current beliefs) that reflect historical events as well as processes. These formulations are by nature incomplete and they are often superstitious. The adaptive impulse to interpret leads us to project cause and effect by presuming that an observed outcome was necessary when it may be accidental or it may have been only one of many possibilities. Nevertheless, we are adaptive creatures in constant feedback with our environments. If such creatures are to survive, they adapt to their environments and they adapt their environments to themselves.

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[30] For a discussion of the epistemological issues of coherence and hierarchical thought, see Haack, S., Evidence and Inquiry, Blackwell, Oxford, U.K., 1993

They develop comprehensively functional adaptive and reifying modes of behavior. This mutual self-realizing and reifying behavior between organism and environment is quite precisely what design accomplishes.

Thus the critical constructivist position is that there is no "truth" per se, but that knowledge is empirical, rational and adaptive in its goals, reflecting species wide processes of adaptation. The empirical bases of knowledge support evolutionary development and variety while the reasoned and goal orientedness of behavior provide a common ground for communication through procedures for perceiving, thinking, remembering, recognizing, etc.

The ethics of such a position require open communication. Each formulation has a point of view or rhetorical position with relations of :

1. plausibility or coherence of knowledge as a whole, consistency with what is currently taken for granted,
2. credibility (are the facts as they need to be),
3. validity (does it make sense as thinking) and
4. comprehensiveness (how complete is it) to that which it examines and the purposes for which it examines.

Our interpretations of communications satisfy some balance of the four criteria above. Because interpretations share these standards in common they can be compared to each other. The ethical standard of open communication does not reflect an entity but

a process: it is not a standard of truth but of the most open and honest environment possible for the furtherance of knowledge.[31]

Psychology

Cognitive psychology operationally describes the mental functions that mediate between external events and human responses. Constructivism – the philosophical position positing that human beings simultaneously observe and create their world – has a history to Vico and Kant. From the view of constructivism, the domain of experience is made up of past and present choices: acts and meanings. Constructivism is highly congruent with cognitive psychology. It proposes a process based evolutionary epistemology as a psychology of knowledge that mirrors symbolic interactionism's sociology of knowledge.[32] It is also congruent with the work of designers, who observe the world, but then actively remake it. The processes that construct meaning also realize themselves through the designer.

In order to build a process based cognitive account of interpretation or meaning production, one must:

1. Redefine the familiar vernacular concepts of meaning concepts in cognitive terms.
2. Develop indicators of cognitive processes and meaning outcomes.

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[31] Habermas, J., Between Facts and Norms : Contributions to a Discourse Theory of Law and Democracy, MIT Press, Cambridge, Massachusetts, pp. 9-10, 1996

[32] Mahoney, M., "Continuing Evolution of the Cognitive Sciences and Psychotherapies," Neimeyer, R., and Mahoney, M., Eds., Constructivism in Psychotherapy, American Psychological Association, Washington, D.C. pp. 44-45, 1995

3. Build experimental tools for measuring cognitive processes according to the indicators

All of this requires the use of psychological concepts used in an empiricist and humanist epistemological frame. Concepts are human constructs based on experience. Any research based on experiential concepts inherits their limitations. Thus, the validity of such terms as memory is in their meaningfulness and robustness: i.e. how satisfactory and consistent they are in enabling us to make sense of experience. In this way we can use experimental results from a variety of different positions such as behaviorist or pure information processing models. We need not agree with the interpretations of behaviorists, for example, to make use of the experimental events that they use to produce results.

Attribution. The concept of "attribution" in psychology defines naming or "seeing as". Attribution refers to the interpretive construction of cognitive objects. It distinguishes between the experience of knowing on the one hand from scientific observation and proof on the other. It is an empirical correlate to the constructivist epistemologies of Maturana and Piaget as well as Symbolic Interactionism and its variants including Ethnomethodology and Affect Control Theory.[33]

Integration and Segregation. Attribution is the integration and segregation of perceptions on the basis of suppositions resulting from past experience. If I report seeing

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[33] Powers, W., Behavior: The Control of Perception, Aldine deGruyter, Hawthorne, New York, 1973

someone mowing his lawn with a lawnmower, I am making attributions. I do not have an absolute or metaphysical knowledge that he is pushing a lawnmower. He appears to be pushing something that I think is a lawnmower on the basis of appearances and my understanding of what a lawnmower is. For example, I hear the sound of its motor, but that, too is attribution, as I may discover if, for instance, part of the sound stops and I discover that what I thought was the sound of the mower was actually a chain saw that was being operated nearby.

Attribution and Validity. Thibault and Kelley provide four criteria we use to validate attributions as judgments about external objects and events that correspond to rhetorical methods of persuasion.

1. Distinctiveness: the impression is attributed to the thing if it uniquely occurs when the thing is present and does not occur in its absence.
2. Consistency over time: each time the thing is present, the individual's reaction must be the same or nearly so.
3. Consistency over modality: reaction must be consistent even though one's mode of interaction with the thing varies. (For example, one sees it to have an irregular outline and feels it to be rough; one first estimates the answer to the problem and then calculates it.)
4. Consensus: attributes of external origin are experienced the same way by all observers.[34]

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[34] Kelley, H., "Attribution Theory in Social Psychology," Nebraska Symposium on Motivation, Vol. 15, p. 197, 1967

Experience. Attribution is a necessity in the domain of experience and where real time interaction is required and in natural languages or methods of communication where multiple discourses or modes of apprehension are simultaneously brought to bear. Attribution operates ahead of warrants. We make attributions with respect to experiences as they are unfolding so that we can anticipate events. We then confirm or modify our attributions through subsequent experience (recognition is a critical constituent of attribution). We apply attributions to construct what we see as external rather than internal realities. Attributions also require consensus: we must agree upon a specific attribution if each of us is to be confident of its validity.

Causality. Fritz Heider describes attribution as the interpretation of events "as being caused by particular parts of the relatively stable environment."[35] This view of attribution has two aspects: temporal patterns and narratives on the one hand, and structural semantics on the other. While causality is at the heart of attribution, attribution does not entail any causal explanation. It simply means relevance or connection under some rubric with an asymmetry of category or space-time. It means only "if 'a' then 'b'". We should distinguish between sensory, geographical, and temporal attributions and categorical or theoretical ones. Sensory attributions concern belief from our senses. I may have misidentified what I saw as a lawnmower, but this was an error of identification not of sense. Geographical and temporal attributions are regularities in the external world. Observed regularities beg questions of cause, but finding out why this is the case is differ-

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[35] Heider, F., The Psychology of Interpersonal Relations. Wiley, New York, p. 296, 1958

ent from observing that it is the case. Theories specify causal links between external events that explain them.

Perception. Attribution is often an unrecognized part of perception. Attributions link events in time and categorical attributions link aspects within structures. Attributions construct everyday perceptions of everyday objects on the basis of perceptual principles of the integration and segregation of sensory data into discrete cognitive objects. Gibson's ecological level of vision[36] is based on our tendency to make attributions and is brought forth to account for:

1. Gestalt effects such as the tendency to perceive wholes as superordinate over parts.
3. Simultaneous effects of bottom-up and top-down methods of interpretation. From initial and partial observations, we generate conceptions of wholes, which we use to organize later phenomena into appropriate parts.
4. The experience of and need for orientation – the sense of knowing a whole of which only a part has been experienced.
5. Expectation – the forward projection of events or entities on the basis of what has already been experienced.

Attribution in Communication. The interpretation of a communication involves a series of attributions about the communication, the intended situation of use, the sender, the sender's knowledge and intentions, the current situation of use, and so forth. Senders provide receivers with ways of improving their informational understandings of the world

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[36] Gibson, J.J., The Ecological Approach to Vision, Houghton Mifflin, Boston, 1979

in terms of the differentiability and stability of attributions.[37] We, as receivers, depend on others for such information and they are persuasive to the extent that we perceive them as being expert and trustworthy. Expertise refers to the credibility of senders' statements and conformity to facts, while trustworthiness refers to the validity of their statements as the "absence of irrelevant causal factors in (personal motives, role demands) in the person's statements."[38]

Sensory Attribution as Proximity. Among types of attributions, sensory attribution provides the ground for other attributions; we have to be able to perceive connection before we can evaluate it. Sensory attribution and the limits of sensory systems of cognition become critical in the construction of judgment in general. For instance, we perceptually associate only those events such as a flash and a clap when they occur within the perceptual window of a second or so. If the lag is greater, we must make a conceptual link as when we count down to thunder after seeing lightning. By the same token, we are likely to perceive connections between any two events that happen at the same time. Perceptual proximity begs the question of whether two events are linked.

Thus, attribution plays a central role in communication both in terms of the relations of persuasion between sender and receiver as participants in communication and regarding the structural design of communications themselves.

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[37] Kelley, H., "Attribution Theory in Social Psychology," Nebraska Symposium on Motivation, Vol. 15, p. 198, 1967

[38] Ibid., p. 204

Cueing Attribution. Communications combine cues that trigger attributions on two levels: sensory and conceptual. Many such cues have become standard conventions. These are not merely cultural conventions as demonstrated by the repeatability of gestalt effects and other experiments in the psychology of perception. For example, experiments demonstrate the tendency to interpolate motion between two states when they are shown rapidly: the phi phenomenon.[39]

The triggering of attributions is critical in sensory communications and in hypermedia where several modes are involved. Where a communication is spoken, the speaker is presented as context. Similarly the writing of a text directly represents the writer. Within highly produced hypermedia, the notion of authorship becomes diffuse and indeterminate. It is up to the document itself to trigger appropriate attributions to cue the receiver's sense of the accuracy, validity and authority of the communication. In addition, given the power of hypermedia to create synthetic sensory experiences, the triggering of sensory attribution has become increasingly important not only as a means for communicating content, but has become part of the content itself.

Simple examples of cued attribution include:

1. Titles: i.e., verbal labels attached to images telling us what the images are about.

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[39] Wertheimer, M., Laws of Organization in Perceptual Forms," Yantis, S. (Ed)., Visual perception: Essential Readings, Psychology Press/Taylor & Francis, Philadelphia, Pennsylvania, pp. 216-224, 2000

2. Narration: in which a video is combined with spoken text with the intent that the text will be seen as commentary about the video, providing an interpretive frame and being combined with the video to form a meaning.
3. Editing for elision: e.g. when a telephone call that ends with "I'll be right over" is followed by the view of a door. The audience assumes that the door is at the place of the person who is to be visited as the other person sees it as he or she arrives.
4. Montage: a number of different "shots" are combined so as to indicate events, e.g., alternating shots of a train moving from left to right and a person on the right standing on a track, who is then perceived as being about to be struck.

Cued attribution can also be presented in logically impossible situations to construct various rhetorical tropes or communicate other concepts. As an example of irony, for instance, we may be shown a bumblebee cruising over a flowerbed while we hear the sound of a B-29 bomber.

Attribution and Meaning Stabilization. The cues used in hypermedia stabilize meaning through synchronic and diachronic configurations. Synchronically, hypermedia combine images and texts. Imagine an image. A boy is batting a baseball in his back yard. As he hits the ball, a man speaks about memories and how "they only give us fragments of how things might have been there and then." Each is subject to multiple interpretations. When the two are juxtaposed, each becomes an interpretive ground for the other. We intuit, or have a sense of "knowing" that this is a childhood photo used as a representation of the fragmentary nature of memory. Thus, in hypermedia presentations, multiple elements serve as grounds for interpreting each other and through others of themselves. Multiple elements within a single image or text, juxtapositions of texts, im-

ages, sounds, videos, etc. and sequences of the same all serve to stabilize meaning. They also established a perceived domain— it's about memory. Baseball is used to indicate the concept and we grasp it by the ways we are prompted to remember and to think about our own memories and senses of things past.

As an example of diachronic or serial configurations, imagine a picture in which we see a red car in front of a green hedge while it is raining, we could have a photograph about a car, a hedge, or rain. If we have three images: car at the left of the image, then center, then right, the subject may be the car or its motion. If we begin and end with no car, then it could be about rain on the hedge, or about appearance and disappearance, etc. Multiple and sequential presentations narrow and deepen the interpretive field by virtue of informing viewers about what happens.

Perception and Thought. Theoretical relations rely not simply on perception, but on conscious thought. Temporal relations require only the observation of regularities. Sensory attributions can be used to imply or offer the possibility of theoretical ones. Temporal and spatial proximities are not logical arguments for relevance. There is no reason why, for instance, a traffic light turns red or green just as I approach. Nor does the appearance of two different news stories on the same newspaper page indicate that they are related.

Perceptual proximity is fundamental to the sensory rhetoric of hypermedia. For instance, the domains of temporal and spatial proximity may be entirely outside of the domain of concepts being communicated in news stories so there may be no grounds for consideration of whether the proximity on a newspaper page is relevant to the content.

Nevertheless, the presentation of two events or entities in perceptual proximity enables us to think about the possibility that they are related.

Reception. Reception is the cognitive result of the receiver's contact with a communication. It is included in what Piaget calls the receiver's "assimilation", "accommodation", and "adaptation".[40] It is reflected in the receiver's ability to identify and think about something received. Operationally, reception has 3 basic interrelated aspects: retention, comprehension, and interpretation.

1. Retention is the stable holding of some aspect of the communication in memory for a period of time. This may take the form of a recollection or ability to answer a question, or skill acquisition, and the length of time may be set at minutes, hours, or years depending upon the purposes of the recollection or mechanisms involved. Put simply, it is the answer to the question, "What do you remember?"
2. Comprehension is the level of integration of the communication as remembered. For instance, if I witness a physics experiment, do I remember it merely as a series of events, like a story, or do I remember it on the level of understanding what the experiment proved. The highest level of comprehension is the level of attribution or identification. It is limited or inadequate to the extent that it is unable to explain or incorporate parts of an experience into an intelligible description.

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[40] Piaget, J., The Equilibration of Cognitive Structures, University of Chicago Press, Chicago, pp. 5-10, 1975

3. Interpretation is the configuration of memory as associations between elements: i.e., remembering "as." Distinct from the level of comprehension, interpretation refers to the qualitative differences between interpretive frames.

Memory and Cognitive Processes. Memory is a critical common ground of cognition in that we cannot think about things we cannot remember. Memory is also a strong indicator of cognitive processing in general. Interpretation and comprehension correspond to the depth of cognitive processing and the patterns or schemas of encoding.

Memory studies often focus on those factors that inhibit and promote long term memory as well as those factors that enhance memory. Inhibiting factors include the cognitive load, interference either from other tasks or within the current task, time allowed for processing, the passage of time, and the number of events between the event to be recalled and recollection. For example, list memorization experiments demonstrate U-shaped recall: i.e. the first and last items being better remembered than those in the middle,[41] longer numbers are harder to remember, the longer a list of numbers the smaller the proportion remembered, etc.

The concern is with mnemonic factors and the characteristics of memory as a constructive and reconstructive process. Mnemonics are those that promote memory or account for the "memorability" of a communication. Regarding memory as a constructive

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[41] Klatzky, R., Human Memory: Structures and Processes, Freeman, San Francisco, p. 14, 1980

and reconstructive process opens questions about what is remembered, how the construction of memory affects subsequent processing and questions of the relation between memories as storage and their subsequent reconstruction.

Attention. There are different attentional stages in processing from awareness that an event is taking place to the identification of the event (a conversation at the next table), to who is speaking, and to the words spoken, etc. If one's attentional processing stops at the event or conversation level (that there was a conversation) the details of that conversation will not be remembered. With respect to schemas, episodic memories, for example, often take the forms of narratives or stories in which details appear as needed like drawer pulls on a dresser of which the person who is recollecting becomes aware as he pulls the drawers open.[42]

Short Term, Working, Long Term Memory. The types of memory such as perceptual storage (2 seconds or less), working memory (used for calculation), and long term memory (stable retention ranging from minutes to a lifetime) reflect cognitive levels or processing from perception to thinking to knowing. Long term memory reflects comprehension and interpretation as the agents which select and organize memory.

Memory and Schematization. Memory is reductive and schematic on all levels whether sensory or conceptual. Memories are not recordings of events, but output from

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[42] Casey, E.S., Remembering: a Phenomenological Study, Indiana, University Press, Bloomington, Indiana, 2000

cognitive processes, which are themselves discriminatory and systematic. Even experiments on memory of words and sounds indicate the importance of schematization. Words or letter combinations that can be schematized are more easily remembered than others. False positive memory errors are greater on words that are synonyms to correct words than to other words including words that sound like the correct words.[43]

We have no direct access to memories but must infer them from behaviors, and there is considerable evidence that the route from memory to behavior is as mediated as the route from sensory events to memories. Bartlett documents processes of simplification, elaboration and conventionalization (substituting familiar forms for strange ones) in memory.[44] There is similar evidence that remembering is more akin to reconstruction occurring at the time of remembering than retrieval.

Reconstruction. Reconstruction during the retrieval phase was also demonstrated when subjects watched a videotape of an automobile accident and later were questioned about it. One group was asked about the speed of the cars when they hit each other. The other group was asked about the speed of the cars when they smashed into each other. Some days afterward, all subjects were asked whether or not there was broken glass at the accident, and the results showed the expected, reconstructive pattern. Among

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[43] Shulman, H.G., "Semantic Confusion Errors in Short-term Memory," Journal of Verbal Learning & Verbal Behavior, Vol. 11(2), pp. 221-227, April 1972

[44] Bartlett, F.C., Remembering; a Study in Experimental and Social Psychology, Cambridge University Press, New York, 1932

subjects asked earlier what happened when the cars hit each other, 14% recalled broken glass. Among those asked earlier what happened when the cars smashed into each other, 32% recalled broken glass, although there was none at the scene of the accident (Loftus and Palmer, 1974).[45]

Memory and Cognitive Procedures. Thus, memory is a result and reflects sensory and cognitive procedures in general. the most powerful mnemonic factors – those which promote memory – are based on pattern or orderliness These "semantic" aspects function on perceptual, event or narrative, and conceptual levels. Studies of patterning or "meaningfulness" demonstrate the mnemonic power of patterning from the increased retention of letter combinations that form syllables over combinations that do not or over numbers, to the increased retention of images with structured relations, to the importance of speech patterning which can result in oral traditions of rhymes which are reproduced unaltered across centuries.[46] Patterns of association result in patterns of recall or self-reminding, and such associations may be asymmetric.

Comprehension. Memories incorporate processes of abstraction and selection that result from cognitive processes. Comprehension may reflect varying levels of completeness in memory and varied levels of processing. For example, the exchange below can be

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[45] Fernald, D., Psychology, Prentice Hall, Upper Saddle River, New Jersey, p. 244, 1997

[46] Rubin, D., Memory in Oral Traditions : the Cognitive Psychology of Epic, Ballads, and Counting-out Rhymes, Oxford University Press, New York, 1995

interpreted on different levels; Rick's replies can be seen as direct responses to questions or ironic statements, which make reference to stories. The comprehension or non-comprehension of his stories represents different levels of comprehension.

> Yvonne: Will I see you tonight?
> Rick: I never make plans that far ahead.
> Captain Renault: …what in heaven's name brought you to Casablanca?
> Rick: My health. I came to Casablanca for the waters.
> Renault: Waters? What waters? We're in the desert.
> Rick: I was misinformed.[47]

Interpretation, Meaning, and Memory. Interpretation is the most complex of the three concepts comprising reception. It is intimately connected with comprehension, but at any level of comprehension different interpretations are possible in the way that readings from a weather report may be seen in a different context by a farmer than a beach goer. Interpretations reflect conceptual frames used to enclose and link information. We are able to imagine multiple frames for interpretation and we are able to construct new frames: i.e., to learn.

Meaning. Semioticians define units of meaning as signs and meaning in terms of behavioral orientation (pragmatics), syntax (grammatical relations of signs as used in language) and semantics (the relations between signs and the significates they point to). The process of signification is one in which the sign evokes a response.

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[47] See Schank, R., Tell Me a Story, Charles Scribner's Sons, New York, p. 37, 1990

Charles Osgood describes the psychologist as "typically interested in the role of the organism's behavior system in mediating the relation between signs and significates."[48] The resulting notion of meaning making is of a multi-mediated process in which the sign evokes a response, which evokes other responses through multiple patterns of association. These associations are differentiating assignations, e.g. hot v. cold mother v. father. Thus, the notions of "cognitive object" and "meaning" have much in common.

Meaning in the vernacular sense includes the pragmatics of evaluative reactions and goals, but the cognitive object itself is a pattern of associations, which define the object's possibilities. These associations comprise the object in memory. They are called forth in the signification process and evaluations may be applied to them.

Memory and Pattern. The notion of interpretation as the configuration of memories rests on the reductive and schematic, i.e., selective and interpretive qualities of memory. Memory associations follow the schemas and semantic relations that express interpretations. Different interpretations correspond to different rates of recall and different patterns of association between elements. Experiments examining recall of narratives demonstrate that the most important parts or episodes are the ones that are most critical

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[48] Osgood, C., The Measurement of Meaning, University of Illinois Press, Chicago, p. 3, 1967

to the structures as wholes and to their outcomes.[49] Thus, elements that can be integrated into schemes should be more memorable than fragments.

Perception and conscious thought are closely related. Both are correlated to meaning. That there is an intimate relation between perceptual and meaningful phenomena is borne out by the confusion which psychologists display in using these terms. … witness particularly the experiment by Carmichael, Hogan, and Walter (1932) in which the deliberate introduction of different meaningful words in association with the same abstract forms markedly influenced the way they were reproduced.[50]

Concepts, recollections, narratives, and perceptions are all methods by which distinct entities can be directly associated with each other:

1. Theories and concepts provide schemas of association.
2. Analogies provide quality or component based paths of association.
3. Narratives provide schemas of serialized events in time.
4. Rhymes and visual patterns provide schemas of repetition.
5. Perceptions reflect temporal proximities as based on the characteristic windows of perceptual cognition.

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[49] Black, J.,, and Bower, G., "Episodes as Chunks in Narrative Memory," Journal of Verbal Learning & Verbal Behavior, Vol. 18(3), pp. 309-318, Jun 1979

[50] Osgood, C., 1967, p. 15

These methods of association result in different connections. In murder mysteries, the proximities of a flow of events are weighed against theories in order to solve a case. The narrative structures support retention of the events enabling consideration of those events and their possible meaning. Purely formal patterns such as rhymes can keep a saying in mind without requiring any understanding of what the rhyme is about. Different schematic methods and levels are typically used together, as in songs and epic poetry. Stories provide patterns of events which support memorability that enables the reader to hold a set of events in mind long enough to work on higher level conceptualizations. Thus, they support the distinction between subject matter and content.

Primacy of Perception. Perceptual methods are primary in that perception constructs direct experience providing base templates for other cognitive systems. For example, when two piano keys are played with less than one tenth of a second interval between them, they are heard as one while if the interval is much greater than one second, they are perceived as separate and with an interval between they are perceived in terms of rhythm.[51] Visual effects include the production of apparent movement by alternating two images. Perceptual methods provide what Lakoff and Johnson call "base metaphors." They are persistent.

Repetition supports the extension of the perception to encompass larger units through mechanisms including: chunking, e.g., perceiving a long number as a series of

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[51] Bregman, A., Auditory Scene Analysis: the Perceptual Organization of Sound, MIT Press, Cambridge, Massachusetts, 1990

shorter ones, or hearing a musical note in the context of the phrase of which it is a part, etc., anticipation of future events in a pattern as well as change or variation from expected pattern. In music, for instance, we hear notes, phrases, and tunes as well as rhythmic and harmonic progressions.

Once the extension of perception takes place, the larger units become contexts for the perception of shorter or more immediate ones, as in gestalt visualizations or highly dissonant musical chords heard not as dissonances but as constituents of harmonic modulations.

Processing and Mnemonics. Each of these is a method for binding experiences into memory. There is reason to expect that retention should be lower where primary identification does not take place than where it does, but there is no reason to presume that one type of processing is uniquely related to memory.

There is evidence that the difficulty of processing is related to memory. William Battig[52] conducted a series of experiments involving "intratask interference" affecting the memory of items that were embedded within lists. This work was conduced within a behaviorist frame, so it describes the "acquisition" and "extinction" of responses given stimuli, but the responses acquired were correct associations from memory, so these were

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[52] See Battig, W., "Intratask Interference as a Source of Facilitation in Transfer and Retention", Thompson, R., Voss, J., Topics in Learning and Performance, Academic Press, New York, pp. 134-146, 1972, or Battig, W., "Facilitation and Interference," Bilodeau, E., Acquisition of Skill, Academic Press, New York, p. 213-241, 1966

memory tests. There were a number of learning trials followed by memory test trials. The items to be remembered were within lists of items that were very much alike or distinctly different – likeness being defined as "interference." With higher levels of interference, learning was much slower as would be expected. But, once learned, long term retention was significantly higher. Within a behaviorist frame, this is a disconcerting result because it strongly points toward the mediation of the cognitive processes which behaviorists rejected, and it is this sort of result which led to the demise of behaviorism as a dominant force in psychology.

Similarly, there is evidence for a relationship between affective response and memory. Such apparently affective characteristics as "vividness"[53] are relatively unimportant, except as, for example, a speaker's vividness communicates other aspects such as his own commitment to his position. Affective reaction does, however, indicate a depth of attentional processing and interpretation; one must be aware of an event, and have interpreted its identity and content to be able to react to it. The relationship between memory and affect[54] reflects depth of processing as much as "affect" per se.

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[53] Collins, R.L., Taylor, S.E., Wood, J.V., and Thompson, S.C., "The vividness effect: Elusive or Illusory?" Journal of Experimental Social Psychology, Vol. 24(1) , pp. 1-18, Jan 1988, and Taylor, S.E., and Thompson, S.C., "Stalking the Elusive 'Vividness' Effect," Psychological Review, Vol. 89(2) , pp. 155-181, Mar 1982.

[54] Ambler, T., and Burne, T., "The Impact of Affect on Memory of Advertising," Journal of Advertising Research, Vol. 39(2) , pp. 25-34, Mar-Apr 1999.

Design Variables in Hypermedia. Hypermedia in particular freely juxtapose materials and modes utilizing sensory attribution to link otherwise disparate elements. Hypermedia manipulate sensory and conceptual methods of attribution by crossing modes.

Thus, hypermedia design presents the following variables:

Perceptual variables:

- Proximity: the apparent relevance of items to each other will be affected by their spatial and temporal proximity. Temporal proximity operates within a perceptual window of two seconds or less; if items occur more than two seconds apart we will not be able to integrate them perceptually.
- Order: the perceptual relations between objects will follow the order of their presentation. Thus, for example, the movement of eyes across an image affects interpretation of that image, and the temporally linear story a root form while the flashback is an inflected one.
- Pattern and sequence: Both are methods of perceptual extension. Pattern is the repetition of a set of elements supporting contextual interpretation of any element, awareness of the grouping the pattern represents, and detection of variation or contrast. Sequence is the production of change through pattern, e.g. the tree that grows over a season.
- Direct semantic relations across mode: Where two modes such as text and motion are combined to enlarge or stabilize meaning, as when an image which depicts but does not directly make attributions is combined with a caption which makes attributions but cannot depict.

Conceptual variables:

- Analogy and metaphor: Analogy is the sense that one entity or event can be processed in the same way as another. Analogy is the basis of concept formation. Metaphor is the invocation of a method of processing, i.e., apply what you know about item a to item b.
- Temporal violation: use of flashback or other non-linear relations in a narrative. In this case, making sense of such an organization may be a challenge. That challenge and the cognitive work it causes may be used to emphasize some conceptual aspect, e.g., asking what caused those later events.
- Indirect semantic relations between modes: Objects in different modes can be combined so as to point toward a content which is distinct from the objects as subject matter. For example, if we see a video of a child batting a baseball while a narrator discusses memories of childhood, we see the video as an exemplar of recollection.

Conceptual challenges like those presented by indirect semantic relations are subsequent to the perceptual ones. Perceptual relations can function without conceptual ones, for example, as decorations, but without perceptual relations conceptual relations are not available. The appearance of the child batting the baseball must be credible and credibly consistent with the text before symbolic relations can be considered. The use of unsteady camera work and scratched black and white film may make footage more credible than high quality digital video, especially if the narrator sounds old. Although these considerations are quite outside the domain of the discourse about memory, they facilitate attribution by modulating the larger domain of naming the communication as a whole.

Summary

Attribution plays a pivotal role in the qualitative reception of hypermedia communications. Attribution is the primary rhetorical tool which designers use to construct a communication and by which they specify the communication as interpretive context and establish its content.

Attribution operates in both perceptual and conceptual domains, enabling us to construct the primary cognitive objects, leading to parallel sensory and conceptual understandings. In order to be taken as credible, a communication must have a credible, coherent interpretation. Prior to that, it must have an appropriately apposite, credible and coherent set of sensory attributes or appearance. Lack of sensory credibility is a major problem in hypermedia.

Contrary to rationalist distinctions between appearance and essence, there is no clear dividing line between perception and conceptualization in terms of their communicative result. They do operate by different rules, i.e. perceptual attribution according to characteristics of sensory cognition as distinct from logical argumentation. Communication designers integrate perceptual and conceptual aspects to make intelligible and reliable communications.

Unfortunately, attribution theory is not, as a whole, well integrated into cognitive psychology to produce theories of meaning production. Perception and memory are viewed more as separable information processors than as interrelated constructors of re-

ality.[55] The experiments conducted in this dissertation will explore the perceptual and conceptual aspects of attribution as methods for constructing meaning.

[55] Neisser, U., Cognition and Reality, W.H. Freeman & Company, New York, pp. 15-18, 1976

CHAPTER III

EXPERIMENT ONE

Overview

The goal of this experiment was to investigate the general hypothesis that human interpretation of communications can be viewed as a "sense making" process triggered as a response to cognitive challenges presented by communications, and its corollaries that this process is consistent across individuals, by examining cross-mode communications and the effects of semantic relations between modes on interpretation.

Its method was to show subjects a number of movies in which a silent video and a spoken text were placed together to form a potential whole, to see whether subjects agreed upon the interpretation of these movies, and if not to look for evidence of common cognitive methods or processes. Insofar as possible, specialized knowledge was not required to interpret movies. It was not important to know who was speaking, or where something was happening. Given the difficulty in interpreting responses to questions like "what was this about," subjects were asked questions with pre-determined responses: whether they could integrate videos and spoken language into intelligible units, how confident they were of their choices, whether they felt that the videos and spoken language were directly related or linked by virtue of their juxtaposition.

In addition to responses, latencies were recorded to study the amount of time required to make responses as indicative of the amount of thought required or difficulty in

making decisions. Latencies could be taken as indicators of cognitive processes which were independent of subject reports themselves.

Finally, subjects were asked to give their interpretations of movies, but these responses were intended not as their interpretations per se, but as records of thoughts most quickly available to subjects: again, indicators of cognitive processes.

The semantic relations between video and language were varied to present different levels of cognitive difficulty in interpretation (Figure 3.1). Responses and behaviors were measured, then aggregated by movie to identify movie properties.

The semantic relations were constructed according to an a priori scheme based on analogic thinking, i.e. that subjects would be able to link videos and spoken language by some comparison or conceptual relations between the two. Most individual responses had pre-determined responses, e.g., yes-no, or low-medium-high. By integrating these responses by movie, rates or indices could be constructed. For example, one movie might be integrated more often than another, or one subject might be more likely to integrate movies than another. Most findings were made on the basis of such indices.

The ability to create indices on the basis of either subject or movie made it possible to use this experiment to compare either subjects or movies, and to test for the effects of background variables like age or sex.

Test Set-up

Subjects. One hundred eight persons participated in this experiment. The target population was normally functioning adults, so the selection of subjects was stratified to reflect varied age, educational status, and sex.

Apparatus. The experiment was executed as a self-contained computer program. It utilized Macromedia Director©, an interactive multimedia authoring program installed on a portable lap top personal computer. This apparatus enabled the experiment to be administered in a variety of non-laboratory environments including restaurants and waiting rooms. Video and audio recordings were also made of the subjects during the experiments. The computer screen was used for video display, and earphones were provided for listening. Most user response was keyed using marked keys on a numeric keypad. The last question asked subjects to describe the movie. For that question, their responses were recorded on videotape for later use.

Software. Macromedia Director© was used to administer the experiment and to record events and times. An add-on program, V-12 DBE Database Engine©, was used to generate a data file for each experimental session recording all significant events and states including the movies shown, user interaction, and times and durations. Unless otherwise stated, all data used was generated by Macromedia Director© and V-12 DBE©. Within the experiments in this dissertation, subjects' descriptions are treated only anecdotally. They were not coded or analyzed.

Protocol. Table 3.1 maps the major sections of the experiment. After background information was collected, subjects were given a tutorial, then a practice section in which

they were asked to key in responses when prompted verbally and visually. This served to acquaint subjects with the experimental protocol and to measure their reaction times. The latency for each response was recorded, resulting in mean Baseline Reaction Times for each subject.

In the integration section, 40 "movies" were shown, each 8 to 12 seconds long. After each movie the subject was asked to indicate:

1. Could the videos and language be integrated into a single unit (Integration).
2. The subject's confidence in the decision (Confidence).

For Integration the subject could respond that videos and language could be integrated into a single presentation or that they remained segregated. A subject could report Confidence as low, medium or high. Each subject was required to respond to each question within 10 seconds.

In the Review section, 10 movies were selected at random from those that had been integrated by the subject and were shown again. This time after each one the subject was asked:

1. Were the video and language about the same thing, or did they find an indirect connection or "link" made by putting them together in the movie (Linkage).
2. What the movie was about, or what it was that enabled them to put video and words together (Interpretation).

Table 3.1. Experiment One, Sections and Data

Section	Description	Data Collected
Sign– in	Enter personal information	Name, Age, Sex, Education
Tutorial	Description and practice of integration section	None
Baseline Reaction Measurement	Input keys on demand	Reaction times
Integration	View 40 movies and answer questions	Integration, Confidence, Integration latency, Confidence latency
Tutorial	Description and practice of review section	None
Review	Review 10 previously integrated movies and answer questions	Direct or indirect linkage, Movie description

Again, subjects were required, within 10 seconds, to rate Linkage by selecting from a direct connection or a link. The Interpretation response was a verbal response which was recorded but not coded.

Data Collection. Of a total of 6,229 records entered, 71 records were removed because subjects failed to respond to prompts within 10 seconds or because of data entry errors, leaving a total of 6158. Baseline Reaction Time data was collected excluding the first 4 trials. Integration section data was collected from the records of the Integration section of the experiment. The test data consisted of 4091 records for the Integration section, 847 for the Review section and 895 records for the Baseline Latency section.

Table 3.2 lists data collected. Integration and Confidence were keyed directly by subjects. The interval between the end of the movie and the Integration response (Integration Latency) and the interval between the Integration response and the Confidence response (Confidence Latency) were computed. In the Review section, the Linkage response was keyed directly and the interval between the end of the movie and the linkage response (Linkage Latency) was computed.

Table 3.2. Data Collected

Section	Variable	Measurement	Data Type	Values
Practice	Baseline Reaction Time	Time required to key in requested responses	interval	milliseconds
Integration	Integration	Reported integration or segregation of movie	nominal	1 = integrated 2 = segregated
	Integration Latency	Time required for integration response	interval	milliseconds
	Confidence	Reported confidence in integration response	nominal	1 = low 2 = medium 3 = high
	Confidence Latency	Time required for confidence response	interval	milliseconds
Review	Linkage	Reported relation between video and words	nominal	1 = direct 2 = indirect
	Interpretation	Description of the movie	verbal	text

Computed Variables. Further variables were derived from information directly collected as indices related to individual movies (see Table 3.3). A movie's Integration Score was the mean of all subjects' integration or segregation of that movie. Similarly, the

Confidence Score of a movie was the mean of subjects' confidence about integrating or segregating the movie. The Integration Latency Score was the mean of all integration latencies for the movie, and the Confidence Latency Score was the mean of all confidence latencies for that movie.

Table 3.3. Movie Variables

Variable	Measurement	Data Type	Values
Integration Score	Mean Integration for movie	interval	range from 1 = always integrated to 2 = always segregated
Integration Latency Score	Mean of Integration Latency for movie	interval	Milliseconds
Confidence Score	Mean Confidence for movie	interval	range from 1 = lowest confidence to 3 = highest confidence
Confidence Latency Score	Mean Confidence Latency for movie	interval	Milliseconds

Results

Baseline Reaction Times. Table 3.4 shows baseline reaction times. The mean of all Baseline Reaction Times was 1326 msec with a standard deviation of 298 msec. Reaction times dropped across the 10 practice trials, from an average of 2530 msec for the first trial, to 1158 msec in the tenth trial. Almost all of the reduction took place from the first to the fourth trial (see Table 3.4). Thus, the mean baseline reaction time was approximately 1174 msec once subjects were acclimated to the procedure.

Table 3.4. Baseline Reaction Times (msec)

Variable	All trials	Trials 4-10
Mean Reaction Time	1326	1174
Median Reaction Time	1283	1099
Std. Deviation	298	381

Background Variables. Because of its limited sample, the study should be taken as suggestive but not conclusive regarding some of its background variables, though it demonstrated methods for taking those variables into account. Findings were targeted toward a general population of normally competent persons, but the sample size and composition must be noted as limitations. A larger and more demographically stratified sample and more complete background information would be needed to overcome the limitations.

Subjects were recruited in a variety of public venues including airports and dining areas as well as through requests for subjects in two universities. Of the 108 subjects, 70 were male, and 38 were female, 101 reported themselves as fluent in English and 7 reported themselves as not fluent. Sixty subjects were under 25 years old and 48 were 25 years old or above. The sample is skewed toward undergraduate students (64% of subjects) and toward males (70% of subjects), but there were adequate numbers of women and older non-students for valid between group comparisons. The number of subjects self-reported as not fluent in English (7 out of 108) was too small for statistical analysis (see Table 3.5).

Table 3.5. Background Variables

Measure	Value	Number	Percent
Age (years)	0-18	15	13.9
	19-24	45	41.7
	25-30	17	15.7
	> 30	31	28.7
Sex	Male	70	64.8
	Female	38	35.2
English	Fluent	101	93.5
	Not fluent	7	6.5
Grades	C	5	4.6
	B	26	24.1
	A	15	13.9
	450 S.A.T	3	2.8
	500 S.A.T	1	0.9
	550 S.A.T	5	4.6
	600 S.A.T	1	0.9
	650 S.A.T	2	1.9
	700 S.A.T	6	5.6
	750 S.A.T	2	1.9
Students	66	61.2	
Non-student	42	38.8	

Subject and Movie Descriptives. Table 3.6 gives mean statistics for variables when aggregated by movie. These scores were used to compare movies. The mean of Integration Scores of movies was 1.56, indicating that movies were slightly more often not integrated than integrated. The standard deviation was 0.146. The 25th percentile of scores was at 1.44, and 75th percentile was 1.67. The mean reported Confidence Score was 2.4 with a standard deviation of 0.24, thus with 25th and 75th percentiles at 2.25 and 2.55 respectively, indicating average reported Confidence Scores as medium to high. The mean Integration Latency was 1,995 msec with a standard deviation of 658 msec yielding a 25th percentile at 1,550 msec and 75th percentile at 2,330 msec. The mean Confidence Latency

was much lower at 958 msec with a standard deviation of 403 msec, yielding 25th and 75th percentiles at 718 msec, and 1,161 msec.

Table 3.6. Integration and Confidence Scores for Movies

Variable	Mean	Standard Deviation	Skewness	Kurtosis
Integration Score	1.56	0.146	-0.065	0.094
Confidence Score	2.41	0.235	-0.197	0.146
Integration Latency Score	1953 msec	658 msec	0.439	1.255
Confidence Latency Score	982 msec	403 msec	0.430	0.422

Background Variables and Integration Variables

Age. Table 3.7 shows Integration Scores, Confidence Scores, Integration Latency Scores and Confidence Latency Scores based on the total subject population and selecting records of different sub-groups according to background variables. The mean of Integration Scores was 1.56 with a minimum of 1.05, maximum of 1.92, and a standard deviation of 0.25, indicating that subjects tended to see more juxtapositions as non integrated rather than integrated, and a broad distribution of integration scores ranging from integrated to not integrated. The mean Confidence Score was 2.41 with a standard deviation of 0.21, a minimum of 1.92, and maximum of 2.88, indicating an average confidence of medium to high, and an absence of very low reported confidence. The mean Integration Latency Score was 1,960 msec with a standard deviation of 22 msec, a minimum of 1,380 and a maximum of 2,537.

Table 3.7. Background Variable Group Comparisons of Integration Variables

Group	Measure	Min	Max	Mean	Standard Deviation
< 19 years	Integration Scores	1.00	1.91	1.48	.257
	Confidence Scores	1.78	2.85	2.37	.241
	Integration Latency Scores	825	2196	1459	342.4
	Confidence Latency Scores	452.4	1439	706.0	184.15
19-24 years	Integration Scores	1.02	1.95	1.562	.271
	Confidence Scores	2.00	2.93	2.436	.217
	Integration Latency Scores	1379	2656	1903	277.1
	Confidence Latency Scores	718.7	1263	960.2	122.7
25-30 years	Integration Scores	1.00	2.00	1.580	0.2824
	Confidence Scores	1.76	2.94	2.378	0.293
	Integration Latency Scores	1468	2243	1862	186.8
	Confidence Latency Scores	688.7	1452	1036	189.3
> 30 years	Integration Scores	1.00	1.97	1.588	0.2612
	Confidence Scores	1.67	2.94	2.414	.2695
	Integration Latency Scores	1471	3064	2294	339.1
	Confidence Latency Scores	895.7	1326	1088	122.2
Male	Integration Scores	1.08	1.90	1.572	0.2458
	Confidence Scores	1.97	2.85	2.438	0.2119
	Integration Latency	1406	2477	1981	231.2
	Confidence Latency Scores	816.3	1181	995.9	103.0
Female	Integration Scores	1.00	1.97	1.549	0.2785
	Confidence Scores	1.84	3.00	2.370	0.2434
	Integration Latency	1334	2643	1924	295.7
	Confidence Latency Scores	722.4	1273	951.8	120.9
Students	Integration Scores	1.03	1.91	1.584	0.2731
	Confidence Scores	2.00	2.87	2.434	0.2145
	Integration Latency	1310	2532	1895	251.2
	Confidence Latency Scores	743.4	1192	955.4	113.1
Non-Students	Integration Scores	1.07	1.93	1.531	0.2420
	Confidence Scores	1.80	2.90	2.3809	.2395
	Integration Latency	1483	2673	2057	254.27
	Confidence Latency Scores	829.0	1203	1017	103.87

The mean Confidence Latency was much lower at 979 msec with a standard deviation of 79 msec, a minimum of 817 msec, and a maximum of 1,144 msec. These indicate much

shorter and more narrowly distributed latencies for Confidence than for integration. Distributions were approximately normal with a skewness reflecting the asymmetry of temporal measures.

Variations in performance between subjects were examined. Age was significantly related to Integration, Integration Latency, and Confidence Latency (see Table 3.8). The mean of Integration Scores ranged from 1.48 for those under 19 years old to 1.85 for those over 30. Scheffé homogeneous groups analysis indicated that the significant relation of age to integration resulted from the greater tendency of subjects under 19 years old to integrate movies.

The other age groups were not significantly different from each other (see Table 3.9). Scheffé homogeneous groups analysis also showed latencies clustering in three groups – under 19, 19 to 30, and over 30 years old – linearly related to age, with older subjects testing slower (see Table 3.10). This result is consistent with Baseline Reaction Times shown in Table 3.4. Thus it is not necessarily indicative of an important difference in cognitive processing.

Sex. Relations between sex and dependent variables were tested using an independent samples t-test (Table 3.10). There were no differences significant at the .05 level between males and females in any identification or baseline measures.

Table 3.8. ANOVA by Age of Integration, Confidence, and Latencies

Dependent Variable		df	F	Sig.
Integration	Between Groups	3	5.561	.001
	Within Groups	4085		
	Total	4088		
Confidence	Between Groups	3	1.563	0.196
	Within Groups	4085		
	Total	4088		
Integration Latency	Between Groups	3	60.01	0.000
	Within Groups	4085		
	Total	4088		
Confidence Latency	Between Groups	3	28.74	0.000
	Within Groups	4085		
	Total	4088		

Table 3.9. Homogeneous Groups for Age of Integration, Confidence, Latencies

Age	Integration Groups		Integration Groups		Latency	Confidence Groups		Latency
	1	2	1	2	3	1	2	3
1.00	1.484		1453			702.6		
2.00		1.563		1862			960.3	
3.00		1.583		1902			1035	1035
4.00		1.588			2296			1089
Sig	1.000	0.803	1.000	0.936	1.000	1.000	0.317	0.605

Table 3.10. Independent Group t-tests for Sex of Integration, Confidence, Latencies

Variable	Sub-group	Mean	Standard Deviation	t-test for Equality of Means t	df	Sig (2-tailed)
Integration	Male	1.572	0.159	1.414	4087	.157
	Female	1.552	0.120			
Confidence	Male	2.4388	0.232	3.067	4087	.002
	Female	2.3682	0.240			
Integration Latency (msec)	Male	1979	732	1.298	4087	.194
	Female	1926	525			
Confidence Latency (msec)	Male	2598	450	1.694	4087	.090
	Female	1491	309			

Academic Status. Relations between college attendance and dependent variables were tested using an independent samples t-test (Table 3.11). The differences between students and non-students, while significant at or close to the 0.01 level, were small compared with standard deviations of the measures aggregated by movie. For example, the mean Integration for students was 1.59 versus 1.53 for non students, while the standard deviations were 0.14.

There was also confounding between age and student status. Most of those in the under 24 years groups were also students, while those over 30 were not students. In short, there was no evidence that student status had a major effect on scores.

Table 3.11. Integration, Confidence, Latencies, Education

Variable	Student Status	Value	t-test for Means	Degrees of Freedom	Sig (2 tailed)
Mean Integration	Student Non-student	1.585 1.532	3.379	4086	0.001
Mean Confidence	Student Non-student	2.434 2.381	2.330	4086	0.020
Mean Integration Latency (msec)	Student Non-student	1893 2056	-4.106	4086	0.000
Mean Confidence Latency (msec)	Student Non-student	953 1016	-2.453	4086	0.014

Fluency. Only 7 subjects reported themselves to be not fluent in English so it was not possible to present significant findings with respect to fluency. There were anecdotal indications that a few of those who reported themselves as fluent English speakers were actually not fluent English speakers. They seemed to misunderstand whole phrases thus misinterpreting language tracks. They appeared not to hear or process phrases, or misidentified them.

The problem of fluency leaves open questions of cultural difference and comprehension. What are the cultural differences in interpretation? Do differences in interpretation reflect different belief systems or ways of thinking, or just misapprehensions? Are misapprehensions random, grammatical, or culturally based? The juxtapositions were designed to avoid dependence on specialized knowledge or vocabulary; they relied on everyday spoken English. Nevertheless, to the extent that a language expresses its culture, it may not be possible to differentiate using this experiment alone.

Summary: Background Variables. To summarize, on the basis of between groups tests of means, there was little indication that the background variables were relevant. Sex was not related to any dependent variables. Age above 18 was not related to integration, and while age and student status were related to latencies, those differences mirrored reaction times. There were small global differences in rates of Integration. No conclusions could be drawn with respect to the role to fluency in English.

These results indicate that with the exception of fluency, the background variables were not important predictors of other variables. These results do not yet in themselves demonstrate that background variables are not important. It could also be the case that background variables mediate other relationships, as will be investigated later in this chapter.

Movies

The 40 movies averaged 8 to 12 seconds each. Each video depicted one event, and words presented one event, statement, or situation. Videos and spoken words were identical in length and shown simultaneously. This strategy was intended to assure that subjects were busy attending to movies while they were being presented.

The semantic relations between spoken words and videos were categorized according to an a priori system to reflect the difficulty of integration, thus the likelihood that any subject would be able to integrate them (see Figure 3.1, Table 3.12).

Table 3.12. Semantic Relations of Videos to Words

Category	Criterion	Example
1	Common Subject Matter	Video: Home movie of children playing baseball. Text Memory records only an abstraction of how things once were.
2	Common Explicit Concept	Video: 2 trains passing from opposite directions. Text: The American "North" and "South" and the importance of common experience in understanding.
3	Common Implicit Concept	Video: elevator doors opening to reveal arctic landscape Words: Depression is an effect of a stroke.
4	Common Concept or Subject Matter	Video: brightly colored stairs panning toward subway sign. Words: As Sherman attacked Atlanta, many moved underground.

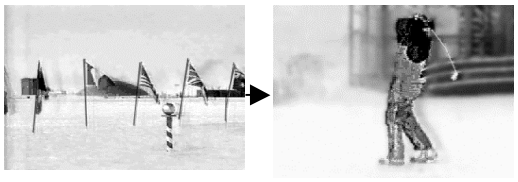
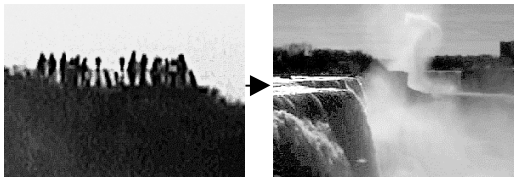
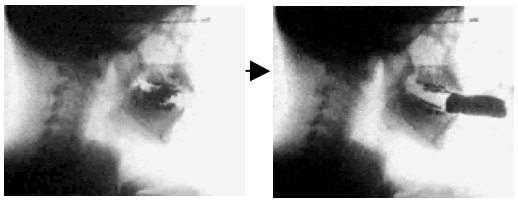
Integration Difficulty	Image Sequence →	Video (description)	Spoken Words
Low		Flags flapping in the breeze followed by man playing golf in the snow.	Thirty below zero with sunny skies. A would-be golfer exercises his fantasy.
Med.		Camera zooms back from persons standing on promontory to large waterfall.	We dump enough heat from power plants to run the whole economy of Japan . . . because the average power plant is fifty miles away from the people who need heat.
High		Motion X-ray of human eating.	. . . when it comes to improving test scores, the quality of computer use is far more important than the frequency of use.

Figure 3.1: Three Movies With Graduated Difficulty of Integration

Findings

Integration Variables. The four part a priori categorization of semantic relations between videos and words was a very good linear predictor of Integration Scores. Mean Integration Scores were 1.30 for category one, 1.50 for category two, 1.67 for category three, and 1.78 for category four (1.00 = always integrated, 2 = always segregated).

There was some overlap of categories indicating other factors at work (see Table 3.13). For example, if category one movies were the easiest to integrate, one would expect category one to include the ten most often integrated movies. The five most often integrated movies are in category one, but the sixth through tenth most likely movies to be integrated are in category two. By the same token, the sixth through tenth most often integrated movies were in category two.

Table 3.13. Semantic Relations and Means for Integration, Confidence, and Latencies

Category	Link	Integration	Confidence	Integration Latency	Confidence Latency	Integration Rank
1	Subject Matter	1.303	2.480	1920	3046	1-5,11, 12, 15, 16, 25
2	Explicit Concept	1.503	2.286	2028	2496	6-10, 13, 22, 27, 33, 38
3	Implicit Concept	1.665	2.376	1914	2580	14, 18- 23, 26, 30, 35, 37
4	No Concepts or Subject Matter	1.781	2.501	1977	3055	17, 24, 28-32, 34, 36, 39, 40

One possible explanation for overlaps may be found in the verbal responses given in the Review section, which indicated that subjects might be linking videos and words not

through conceptual analogies but using narrative structures. For instance, in one movie there was a video of a young man being put in the back of a police car, while a woman spoke of "his" anger. One typical response was that "He's the one who must have attacked her, and she reported him."

In short, the a priori categorization could be further examined and refined on the basis of the empirical outcomes, but it was a good first attempt at the production of movies with varying difficulties of integration. The resulting movies could also be examined regardless of the theory informing construction and analyzed in terms of their reception.

Integration Scores for movies varied from 1.05 (almost all subjects integrated) to 1.92 (almost all subjects segregated). The mean Integration Score was 1.56, with slightly above half of subjects unable to integrate the average movie. The scores indicated that there were a few movies that almost all subjects segregated, a few that almost all subjects integrated, and many movies in between, upon which there was no consensus. The shape and distribution of identification scores reflects the choices and design of juxtapositions as well as the subject matter, but they demonstrate that it is possible for different subjects to identify juxtapositions differently (see Table 3.14).

Confidence Scores. Confidence Scores were the mean levels of confidence for each movie (see Table 3.14). Mathematically possible scores ranged from 1 (low confidence reported by all subjects) to 3 (high confidence reported by all subjects). The measured mean of Confidence Scores for all movies was 2.41: between moderate and high confidence. The minimum score was 1.92 and the maximum was 2.88.

Table 3.14. Movie Scores

	Integration Score	Confidence Score	Integration Latency (msec)	Confidence Latency (msec)
Mean	1.61	2.4092	1980	994
Median	1.56	2.3432	1624	816
Standard Deviation	0.255	.2150	1256	799
Measured Minimum	1.05	1.92	250	83
Measured Maximum	1.92	2.88	9500	8666

Latency Scores. Integration Latency scores were the mean latencies required to key in integration or segregation for each movie. The mean of Integration Scores was 1980 msec with a minimum of 250 msec and a maximum of 9,500 msec (see Table 3.14). The mean Baseline Latency was 1,200 msec. The difference between mean Baseline and Integration Latencies indicated that subjects used an average of 780 msec for decision making. The range of Integration Latencies was considerable, with the shortest latencies indicating that subjects sometimes anticipated questions.

Confidence Latencies were much shorter than Integration Latencies, with a mean of 994 msec. That mean score is below the mean Baseline Latency of 1,200 msec. Once subjects decided whether a movie could be integrated or not, they were quickly able to give their confidence, indicating that indicating confidence was not a matter of judging or analyzing but of reporting a response that had been previously elicited either by the movie or by the Integration question.

Regression Relations Between Variables. Table 3.15 and Figure 3. show significant relationships of regressions between Integration, Confidence, and Latencies. Relations between Integration Scores, and Confidence Scores and Integration Latency were quadratic, or U-shaped with no significant linear relations.

Table 3.15. Regressions of Integration Scores, Confidence Scores, and Latencies

Regression Measure	Integration Score and Confidence Score	Integration Score and Integration Latency Score	Integration Score and Confidence Latency Score	Confidence Score and Confidence Latency Score
Curve	Quadratic	Quadratic	Quadratic	Linear
Multiple R	0.533	.541	0.579	0.573
Rsq	0.284	.293	0.336	0.328
Adjusted Rsq	.2839	.254	0.300	0.310
Standard Error	189.9	198	66.4	0.178
Sig F	0.000	0.002	.0005	0.000

Confidence scores were highest when Integration Scores were low or high, and lowest when Integration Scores were at midpoint. The quadratic component was strong, with an adjusted R square = 0.284, and a 0.000 level of significance.

Similarly, there was a largely quadratic relationship between Integration scores and Integration latencies. Mean latencies were lowest for high and low Integration Scores, and highest at midpoint (see Figure 3.2). The movies on which subjects agreed could or could not be integrated were also the ones about which they could make their decisions most quickly, but the ones in the middle were more difficult for them to resolve. The

quadratic component of the relationship had an adjusted R square of 0.254 with a 0.002 level of significance.

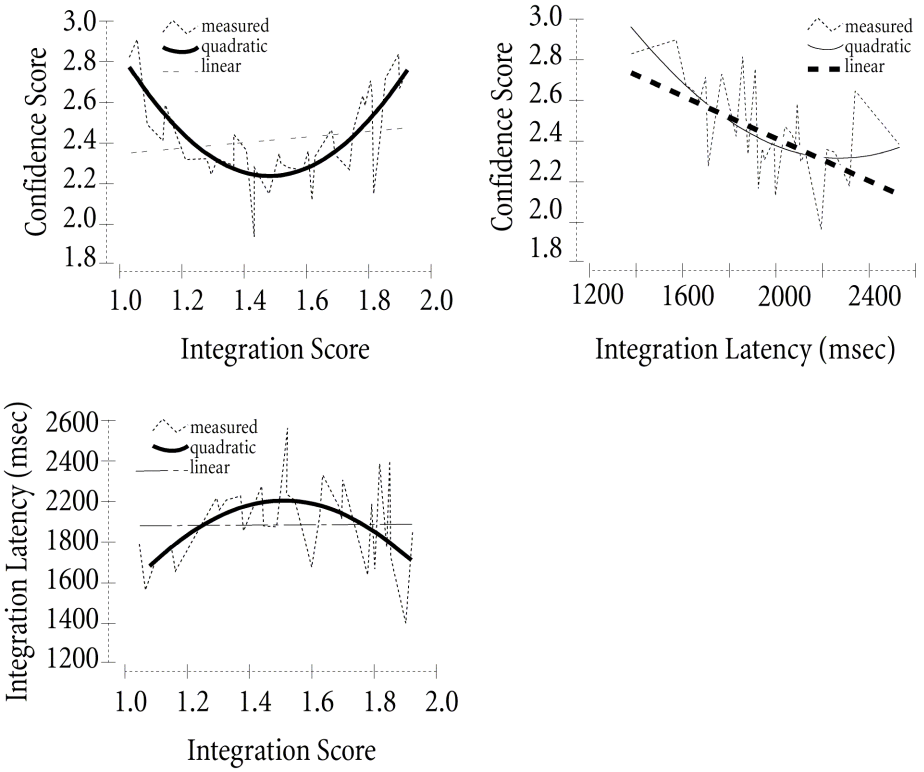


Figure 3.2. Regressions of Integration, Confidence, and Latencies

Confidence Latency Scores were quadratically related to Confidence Scores. The lowest scored movies had the highest latencies, indicating that low confidence was indicative of cognitive difficulty or ambiguity mitigating judgment with respect to integration. Confidence Latency Scores were linearly related to Integration latency Scores, which is consistent with the interpretation that they both reflect cognitive difficulty.

Background Variables and Comparisons of Regression. As stated above, background variables were not important factors affecting mean scores. Table 3.16 indicates

that they were also not intervening variables in relations between Integration Scores, Confidence Scores, and Latencies. The regressions between Integration Scores, Integration Latency scores and Confidence Scores remained significant for all subgroups according to Age, Sex, and Student status. The similarities of regression curves and variances explained indicate the relationships between these variables were similar for all groups. Insofar as these relations indicate underlying cognitive mechanisms and difficulties, they were the same for all groups.

Table 3.16. Inter-group Comparisons of Integration and Confidence Regressions

Variables	Regression		Age (yrs)				Sex		Student Status	
			< 19	19-24	25-30	> 30	Male	Female	Student	Non-student
Integration and Confidence	Quad-ratic	Adjusted Rsq	0.18	0.70	0.462	0.29	0.40	0.62	0.37	0.37
		Sig f	0.01	0.00	0.000	0.00	0.00	0.00	0.00	0.00
Integration Latency and Confidence	Linear	Adjusted Rsq	0.277	0.153	0.20	0.27	0.20	0.40	0.32	0.37
		Sig f	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Review Variables. After completion of the integration section and tutorial, the review section followed in which each subject reviewed 10 movies chosen and ordered at random from those the subject reported as integrated. After each movie was reviewed, the subject was asked whether the video and spoken language were directly or indirectly related (Linkage). For example, if the language described childhood and the video showed old movies of children playing, the two could be seen as fitting together directly. If, by contrast, the text was about the depression following strokes, while the video

showed a bleak arctic wasteland, the two could more likely be seen as separate but linked by the movie.

The Linkage response was recorded and Linkage Latency was measured. Each review record also included data collected when the movie was shown in the Integration part of the experiment. Table 3.17 shows descriptive statistics for review records aggregated by movie. Mean tendencies to see videos and words as directly or indirectly related were computed into Linkage Scores for each movie, ranging from 1 for always directly related to 2 for always indirectly related, and Linkage Latency Scores, the mean latencies for reporting direct or indirect linkage.

Table 3.17. Frequencies in Review Records

	Integration Scores	Confidence Scores	Integration Latency Scores	Confidence Latency Scores	Linkage Scores	Linkage Latency Scores
Mean	1.000	2.092	2053	962.0	1.590	2280
Standard Deviation	0.000	.3133	477.3	223.2	0.1916	461.2
Variance	.000	9.816E-02	227852	49802	3.671E-02	212699
Skewness		.535	1.138	0.784	-0.139	1.425
Kurtosis		.822	1.415	1.047	0.251	2.243

The mean of Linkage responses was 1.59, indicating that more movies were recorded as indirectly related than directly related. The mean of Linkage Latencies was 2,280 msec, somewhat above the mean of Integration Latencies and well above the mean of

Confidence Latencies. The greater latencies indicate that cognitive processing was involved in terms of the movie and/or the question asked.

Linkage Scores were related to Integration Scores and Confidence Scores: Movies that were more often integrated were also more often seen as directly fitting rather than linked (see Table 3.18). The relations were strong and linear, with an adjusted R square of 0.520 relating Linkage Score and Confidence Score, and an adjusted R square of 0.347 relating Linkage Score and Integration Score. In short, Linkage represented the reportage of the phenomenologies of cognitive difficulty and success.

Table 3.18. Regression of Linkage, Integration and Confidence Scores

	Linkage Scores and Confidence Scores		Linkage Scores and Integration Scores	
Method..	Linear	Quadratic	Linear	Quadratic
Multiple R	0.6678	0.7380	0.6030	0.6048
R Square	0.4458	0.5445	0.3636	0.3658
Adjusted R Square	0.5199	0.4313	0.3469	0.3315
Standard Error	0.2194	0.2388	0.2058	0.2082
Sig F	0.000	0.000	0.000	0.000

Anecdotal Reports. Subjects were asked to interpret review movies by reporting either "what they [were] about" or "what enabled you to put them together." Responses were collected not as reports of interpretation but as records of thoughts that were most

easily available to subjects soon after looking at movies. These responses were not coded, so any comments about them are anecdotal. The expectation was that subjects would offer either interpretations that gave an overall concept or context to the movie or that linking analogies would be offered. Instead, subjects responses habitually concerned narrative structures or events, e.g. that a person depicted in a video was the one being talked about or the one responsible for something described, even when there was no evidence of the linkage.

Summary of Major Findings

1. Organizing data by movie shows major relationships between indices of integration, levels of confidence and latencies.
    a. Movies with high and low scores in integration were associated with equally high levels of confidence and equally quick subject responses.
    b. Medium integration scores were associated with low confidence and slow responses.
    c. Slow responses in integration were associated with slow responses in reporting confidence.
    d. Once integration responses were keyed in, confidence responses were made much more quickly.
    e. An a priori classification of semantic video-language relations which was intended to predict integration scores was a moderate approximation to the scores observed.
2. While subjects' background variables were related to minor differences in their rates of Integration, Confidence, and Latencies, the relations between these variables remained constant for all subgroups.

Discussion

This experiment was concerned with the extent to which and the ways in which people are similar or different in their interpretations of communications, and with the cognitive processes they used to process them. The communications minimized reliance on special knowledge to key interpretation, but presented challenges in combining or integrating spoken texts and videos together.

The Integration Scores of movies were roughly normal. Half of the movies received Integration scores between 1.78 and 1.38, indicating that while there were some movies on which almost all subjects agreed that they made sense or not, there were many on which there was considerable "disagreement". The actual mean and distribution were to some extent results of the criteria used to generate the movies, but however they might be refined, the actual mean and distribution demonstrate that it is routinely possible to make combinations that make sense to almost everyone, to almost no one and which fall between.

Given the range and distribution of Integration Scores, it is certainly reasonable to argue against notions of “unlimited semiosis” or “unlimited interpretation” tending toward the notion that sensory stimuli can be juxtaposed almost at random and still be “reasonably” interpretable. It does not yet give any indication as to the nature and source of the differences of opinion over whether a given juxtaposition is interpretable.

The causes of interpretive differences were probed primarily by two variables: Confidence Score and Integration Latency score. Two main reasons for differences in interpretation were hypothesized. Either persons disagreed as matters of opinion based on

knowledge, attitude, or thought process, or the communications were ambiguous to the point that subjects were guessing to a greater or lesser extent. Were these matters of opinion or belief, subjects should be as confident where they disagree as where they agree, but if they felt confused, confidence would drop. In addition, if a juxtaposition made intuitive sense, that could be directly perceived, a subject could respond quickly, but if the subject was having difficulty making sense he or she would need more time to respond, thus, latencies would rise.

The variable Confidence Scores indicated that where subjects do not agree that movies can or cannot be integrated, they have lower confidence and they respond more slowly. In the relationship between Integration Scores and Confidence Scores, there was almost no linear component indicating that for extreme movies, subjects were equally confident in deciding that juxtapositions do or do not make sense. For those movies that were in the middle, subjects' confidence dropped, resulting in the U-shaped quadratic relation. The adjusted R square of 0.284 indicated a substantial relation between the mean level of Confidence for a movie and its Integration Score.

The variable Integration Latency Scores also showed a strong quadratic relation to Integration Scores. Again, the linear component was very small though significant, explaining 2.5% of the variance, but the quadratic component explained 25%. Subjects spent more time thinking about the movies with mid range integration scores.

In short, Integration Scores, Integration Latencies, and Confidence Scores, when taken together, indicated that the apparent differences in judgment on the integration of movies were results of perceived ambiguity, not differences of opinion or beliefs. That

commonly perceived ambiguity is evidence of modes of cognitive processing: perception, thinking, inferring and concluding that are universal or widely shared among subjects. Persons' interpretations may vary culturally or idiosyncratically on the basis of knowledge or beliefs, but their methods of processing are shared and can be experimentally uncovered.

It seems likely that the Confidence judgment was reached as a part of the integration judgment. Confidence Latency Scores were well below Integration Latency Scores, and their standard deviation was much smaller. There was also no significant relationship between Confidence Latency Scores and Integration Scores. Together, these give strong indication that subjects knew their levels of confidence before the prompt for that response was given.

If this is the case, the short Confidence Latency Scores indicate that integration or non-integration could be regarded to be as much an act as an observation, i.e. a commitment to see or reject the juxtaposition as a single movie, and on that basis to settle on a position and go on to the next significant problem. In this experiment, that would be the next movie. If so, anything that affects decision making positively or negatively, either by steering choices or by temporal interference can be quite relevant to any aspect of reception: interpretive organization, memorability, or comprehension.

The Linkage variable did not add new information. Linkage Scores mirrored Integration Scores linearly with 36% of the variance in Linkage Scores explained by Integration Scores. Linkage scores were also strongly related to confidence scores with both linear and quadratic components.

In this experiment, efforts were made to persuade subjects not to treat it as a test of their ability to make sense of things, but subjects may nonetheless have treated it in that way. This may be unavoidable and it is consistent with everyday recognition problems in which the production of an interpretation that credibly encapsulates an event is important in the continuation of whatever activity is being undertaken. The U-shaped relationship between Integration Scores and Integration Latency Scores, indicates that there was no unwillingness to determine that movies could not be integrated.

Finally, the anecdotal evidence of Interpretation responses suggesting that the first integration of experience may be narrative rather than conceptual or analogic is an important potential direction for further study.

CHAPTER IV

EXPERIMENT TWO

Overview

The goal of this experiment was to test the effects of mode of communication and of temporal shifts between modes on reception and memory. While experiment one varied semantic relations between videos and words, experiment two varied temporal relations between video and words. While experiment one tested integration, confidence, and reports of the perceived connection between video and words, experiment two tested integration, confidence, reported cognitive difficulty, affective reaction (like-dislike) and recall.

Like experiment one, experiment two showed each subject a series of movies in which a silent video and a spoken text were combined to form a potential whole, in order to see if subjects agreed upon the interpretation of these movies, and if not, to look for evidence of common cognitive methods or processes. Insofar as possible, specialized knowledge was not required to interpret movies; it was not important, for example, to identify who was speaking or where something was happening. As in experiment one, subjects were asked multiple choice questions: whether they could or could not integrate videos and spoken words into intelligible units, how confident they were of their choices, how much difficulty they had in making sense of the movies and whether they liked them or not.

Test Set-up

Subjects. There were 152 subjects in experiment two. The target population was normally functioning adults, so the selection of subjects was stratified to reflect varied age, educational status, and sex. Subjects were recruited in lunchrooms and restaurants, waiting rooms, libraries and requests for subjects at a university, as well as airports and other public venues.

Apparatus. Experiment two used the same apparatus as experiment one (see page 70), except that marked keys on the standard keyboard were used for keyed input. As in experiment one, the last question asked subjects to describe the movie. Responses to that question were recorded for later coding and analysis but not incorporated into this study.

Part 1: Description

This part was most concerned with relationships between temporal proximity and reception. It tested the idea that persons would be most likely to conceptually associate things that are presented in temporal proximity. Thus, skewed temporal relations would themselves make interpretation more difficult and reduce intelligibility, and affective reactions that require depth processing would be inhibited (it is difficult to have an emotional reaction to something you have not yet identified).

Hypotheses:

The effects of delays will be as follows:

1 The rate of integration of video and words will drop with delays.

2 Latency for reporting integration will increase reflecting cognitive difficulty.

3 Confidence will decrease reflecting cognitive difficulty.

4 The reported cognitive difficulty will increase.

5 Affective reaction to content will decrease.

Protocol. Experiment two used 20 of the movies which had already been used in experiment one. In experiment two, however, the temporal relations between video and spoken words were altered yielding nine possible states of temporal relation including synchronized (identical to experiment one), and with either video or spoken words delayed by one second, with one second overlap, with no overlap, or with a one second gap between whichever mode was first and the mode presented second (see Figure 4.1).

As in experiment one, subjects were asked a series of questions. Responses and latencies were recorded to indicate the thought required or difficulty in making decisions.

The re-use of movies and questions from experiment one made it possible to confirm the findings of experiment one and compare the effects of semantic relations with perceptual relations such as relative timing. New questions, such as reported cognitive difficulty and affective reaction added affective dimensions to measurement, and tests of recall could relate these variables to retention as a measure of communicative effectiveness.

In part 2 of this experiment, subjects' recall of the movies was tested. The words from one movie were displayed with videos from four movies or the video from one movie was displayed with the words of four movies. Subjects were asked to correctly match video and words that were together in a single movie they saw earlier (see Figure 4.2). In this way, video could be used as a cue for the recollection of spoken words or

spoken words could be used as a cue for the recollection of video. Thus, it was possible to detect asymmetries: that different modes could be more or less powerful in cueing recall.

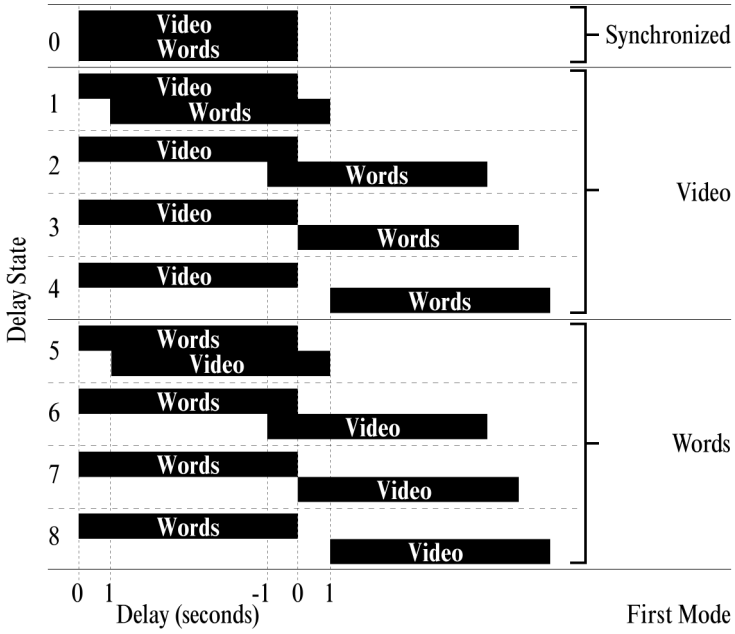


Figure 4.1. Delay States and Mode Precedence

Figure 4.2. Memory Tests Matching Words and Videos

Table 4.1 maps the major sections of experiment two. After background information was collected, subjects were given a tutorial, then a practice section in which they were asked to key in responses when prompted verbally and visually. This served to acquaint subjects to the experimental protocol and to measure their reaction times. The

latency for each response was recorded, resulting in mean Baseline Reaction Times for each subject.

Table 4.1. Experiment Two, Sections and Data Collected

Section	Description	Data Collected
Sign in	Enter personal information	Name, Age, Sex, Education
Tutorial	Description and practice of integration section	None
Baseline Reaction Measurement	Input keys on demand	Reaction times
Part 1: Integration	View20 movies and asked questions	Delay state, Integration, Confidence, Cognitive difficulty, Content reaction, Integration latency, Confidence Latency, Cognitive Difficulty Latency,
Tutorial	Description and practice of review section	None
Part 2: Review	Review movies and asked to identify	Correct-Incorrect Identification, Confidence, Identification Latency, Confidence Latency, Description

In part 1, 20 movies were shown. Movies were randomly ordered, as were the relative timings of videos and spoken words. Thus, each subject saw all movies in random order, and each subject watched each movie in one of nine possible temporal states, also chosen at random. After each presentation, subjects were asked to respond to questions as shown in Table 4.2. For Integration, the subject could respond that videos and language could or could not be integrated into a single presentation. Subjects reported the difficulty they experienced in interpreting the movie on a five value scale from 1 (very difficult) to 5

(very easy). Subjects rated their affective reaction to the movie's content on a five point scale ranging from 1 (very negative), to 3 (neutral) to 5 (very positive). A maximum of 10 seconds was allowed for each response.

Table 4.2. Experiment Two, Part One Variables

Variable	Data type	Values
Integration of Video and Words	Nominal	1 = integrate into a single unit 2 = remain 2 separate units
Integration Latency	Interval	Milliseconds = response time
Confidence	Ordinal	1 = low 2 = medium 3 = high
Confidence Latency	Interval	Milliseconds = response time
Ease of Interpretation	Interval	1 = very difficult 2 = somewhat difficult\ 3 = average 4 = somewhat easy 5 = very easy
Ease of Interpretation Latency	Interval	Milliseconds = response time
Content Reaction	Interval	1 = strong dislike 2 = moderate dislike 3 = indifferent 4 = moderate like 5 = strong like
Content reaction Latency	Interval	Milliseconds = response time

The questions also supported the computation of additional variables. Delay State was recomputed into a Delay index of five states from no delay to a 1 second gap, and as mode Precedence in three states: synchronized, video first, and words first. Similarly, Content reaction was recomputed into Strength as strength of content reaction on a 3

point scale from no reaction to strong reaction, and into Pos-Neg reaction, a three point scale of negative, no reaction, and positive reaction to content (see Table 4.3).

Table 4.3. Experiment Two, Part 1, Secondary Variables

Secondary Variable	Source	Type	Values
Delay	State	Nominal	0 = synchronized 1 = 1 sec. Delay 2 = 1 sec. Overlap 3 = 0 sec. Overlap 4 = 1 sec. Gap
Precedent	State	Nominal	0 = Synchronized 1 = Video first 2 = words first
Strength	Content Reaction	Interval	0 = no reaction 1 = moderate reaction 2 = strong reaction
Pos –Neg	Content reaction	Nominal	-1 = Negative reaction 0 = No reaction 1 = Positive reaction

Background Variables. As in experiment one, subjects were asked to fill out background information including Age, Gender, English fluency, and educational status [Grades] (see Table 4.4). There was also a tutorial in which subjects were asked to practice keying in responses that measured their baseline reaction times.

Table 4.4. Background Variables

Background Variables	Values
Age	1 = 19-24 yrs. 2 = 25-30 yrs. 3 > 30 yrs.
Sex	1 = male 2 = female
English Fluency	1 = fluent 2 = not fluent
Grades/Student Status	1 = D grade average 2 = C grade average 3 = B grade average 4 = A grade average 5 = Non-student

Statistical Methods and Category Variables. While many of the data and variables were similar in the two experiments, the statistical methods were different. In experiment one most comparisons could be expressed as interval data making it possible to use regressions. Experiment two required the use of data organized in categories. Experiment two used cross-tabulations and analyses of variance (ANOVA) to determine differences in grouped data.

Because of the predominance of three to five category measures, some ordinal or continuous measures were also categorized into quintiles, allowing for commensurable statistical analyses that facilitate comparisons (see Table 4.5). The number of five categories was a compromise: large enough to permit detection of non-linear relationships while small enough to avoid a large number of cells that would make significant relationships difficult to detect.

Table 4.5. Categorical Measures

Categorical Measure	Source	Values
Integration Latency 5	Integration Latency	1-5 at quintiles
Confidence Latency 5	Confidence Latency	1-5 at quintiles
Ease Latency 5	Ease Latency	1-5 at quintiles
Content Latency 5	Content Latency	1-5 at quintiles

In experiment two, ANOVAs were used with Scheffé tests of significance. Scheffé measures of inter-group differences were used to analyze non-liner relations and Scheffé "Homogeneous Subsets" measures were used to find clusters of responses. Unless otherwise specified, ANOVAs described as significant were significant at the 0.01 level of significance (99% confidence that the result is not possible by chance). Homogeneous groups and inter-group difference analyses used the 0.05 level of significance (95% confidence) according to Scheffé tests as available within the SPSS Version 10.0 statistical programming package. Relationships near but not at the required levels of significance were referred to as "possible," or "suggestive."

ANOVA's require the generation of multi-celled tables and in some cases there were insufficient populations in certain cells for accurate statistics. In those cases the lack of statistical significance does not necessarily indicate a null hypothesis, just a weak or unprovable one. Tables and graphs were generated in SPSS version 10.0.

For some measures, cross-tabulations were used to test for multiple factors yielding limited results. Despite the large number of subjects and records (137 subjects and 10,500

records) cross tabulation has its limitations. When cross-tabulations are made using more than one factor, the number of cells or groups multiplies and it becomes difficult to have a large enough population in each cell to test for significance.

Part 1: Results

Background Variables. Table 4.6 displays the frequencies of background variables. As it shows, the sample was somewhat skewed toward younger subjects (57% under 25 years old), students (52% student), and males (57%). Nevertheless, there were enough subjects in all represented categories for statistical analysis.

Table 4.6. Experiment Two Background Variables

Group	Frequency
All subjects	152
19-24 years	82
25-30 years	34
> 30 years	36
Male	87
Female	65
Student	78
Non-Student	74

As in experiment one, comparisons of sex and age based groups did not disclose that background variables significantly affected results. These results mirror results in experiment one, except for the different latencies on the integration question between students

and non-students. In experiment one their latencies were higher while in experiment two they are lower. The temporal manipulations in this experiment made the cognitive jobs substantially different in experiment two from experiment one so there is no necessary conflict here. Moreover, differences in latencies are consistent with differences in baseline latencies for students and non-students and with no differences in responses, these differences have no practical effect.

With respect to sex, as demonstrated in Table 4.7, in general there are no substantial relationships between sex and any performance variables. Men and women answer all questions the same ways. The only possible exception is in Content Latency, which indicates that women answer that question more slowly than men.

Table 4.7. Performance Variable Means for Male and Female

Variable	Sex	
	Male	Female
Integration	1.59	1.61
Integration Latency	1887	1884
Confidence	2.45	2.37
Confidence Latency	1401	1447
Ease	3.70	3.61
Ease Latency	2194	2354
Content	3.11	3.01
Content Latency	1636	1919

Similarly, age had no significant effect on responses but did have an effect on laten-

cies as shown in Table 4.8. Latency measures suggest increased latency with age.

Table 4.8. Performance Variable Means for Age Groups

Variable	Age Group 18-24	25-30	>30
Integration	1.60	1.59	1.60
Integration Latency (msec)	1796	2058	1925
Confidence	2.37	2.54	2.39
Confidence Latency (msec)	1354	1388	1606
Ease	3.67	3.69	3.61
Ease Latency (msec)	2200	2249	2417
Content	3.07	3.12	3.02
Content Latency (msec)	1662	1753	1976

Comparing students and non-students, there were again no substantive differences in the responses (see Table 4.9). Means of Integration, Confidence, Ease, and Content were virtually the same for both groups. There were differences in latencies; student latencies were between 100 and 200 msec lower. Student status is strongly related to age: 92% of students were under 25 years old with the rest under 30, while only 14% of non-students were under 25, 35% of non-students were between 25 and 30 and 51% of non-students were over 30. Increased latencies were consistent with increased latencies for older groups and measured relations between age and baseline reaction times, which showed a difference of up to 700 msec in reaction times between the youngest and oldest age groups.

Table 4.9. Performance Variable Means for Students and Non-Students

Variable	Student Status	
	Non-Student	Student
Integration	1.59	1.60
Integration Latency (msec)	1946	1824
Confidence	2.43	2.40
Confidence Latency (msec)	1489	1361
Ease	3.65	3.67
Ease Latency (msec)	2321	2210
Content	3.02	3.11
Content Latency (msec)	1882	1645

Descriptive Statistics. The mean Integration for all trials was 1.61, indicating that subjects were slightly more likely to determine that integrations were not possible. This figure reflects differences between movies and the effects of delays. The mean Confidence score was 2.41 indicating that subjects were most likely to score high confidence. The mean reported Ease was 3.65 out of a possible 5 showing a tendency to report movies as easy than as difficult, and the mean Content reaction was 3.08, indicating a neutral average.

Frequencies and mean scores of performance variables are shown in Table 4.10 and Table 4.11. Of Confidence scores: 54% were high, 33% were medium, and 13% were low. Ease scores were very hard (1) 4.9%, moderately hard (2) 10.8%, medium (3) 25.3%, moderately easy (4) 31.3%, and very easy (5) 27.2%. The modal score was moderately

easy (4). Content reaction scores were very negative (1) 8.9%, moderately negative (2) 19.9%, no reaction (3) 38.7%, moderately positive (4) 19.4%, and very positive (5) 13.1%. The modal score was (3) no reaction. Frequencies were lowest for strong reactions either positive or negative.

Table 4.10 Frequencies in Non-Interval Measures

Variable	Value	Percent
Integration	Integrated	40.3
	Not Integrated	59.7
Confidence	Low Confidence	13.0
	Medium Confidence	32.7
	High Confidence	54.3
Ease	Ease = 1	4.7
	Ease = 2	10.9
	Ease = 3	25.5
	Ease = 4	30.7
	Ease = 5	28.0
Content Reaction	Content = 1	9.1
	Content = 2	19.8
	Content = 3	38.3
	Content = 4	19.5
	Content = 5	13.1

Table 4.11. Means of Measures

Variable	Mini-mum	Maxi-mum	Mean	Standard Deviation
Integration	1	2	1.60	
Integration Latency	300	9400	1879	1061
Confidence	1	3	2.41	
Confidence Latency	216	7683	1419	791
Ease	1	5	3.66	
Ease Latency	166	9716	2263	1113
Content Reaction	1	5	3.08	
Content Reaction Latency	116	9100	1758	1120

Latencies were normally distributed with a skewness consistent with the nature of a temporal variable that extends infinitely in the positive direction but has no negative direction (ending abruptly at 0 time). The mean Integration Latency was 1,879 msec. The mean Confidence Latency, 1,419 msec. The mean Ease Latency was 2,253 msec. The mean Content Latency was 1,736 msec. There relatively long latency for cognitive ease is consistent with the notion that the question asks for meta-knowledge, i.e. that the subject stops thinking about the communication to think about his/her reaction to it.

Comparisons of Experiment One and Experiment Two. Both experiment one and experiment two asked subjects to indicate whether the videos and spoken words belong together (Integration) and to indicate their level of confidence (Confidence) in that judgment. This parallel enabled the results of the two experiments to be compared as a

crosscheck. Two questions are involved. First, are movies generally less or more often integrated if they are delayed, and second, is the effect the same for all movies or do delays inhibit the integration of some movies but not others.

The results of experiment one were confirmed in experiment two. With respect to Integration and Confidence, the evidence was strong that the effect of Delay is significant and consistent. The evidence was also strong for Integration Latency.

In experiment two, there were 9 Delay States, of which 8 represented delays and one represented synchronization, corresponding to experiment one (see Figure 4.1). Scores were constructed reflecting mean Integration and Confidence responses as well as latencies of responses according to each movie.

The mean of all Integration and Confidence scores was the same for experiment one as for experiment two, when videos and words were synchronized. The mean Integration was 1.47 for experiment one and 1.51 for experiment two when synchronized. That mean Integration rose to 1.60 for all Delay States in experiment two. When the Integration scores of movies (between movie scores) were compared, there was an R square of 0.86 indicated that the same movies were easy and difficult in both cases. The R square between Confidence scores was 0.56 for synchronized movies in experiment two. When all states were included, the R square increased to 0.79.

Experiment one established a U-shaped relationship between Confidence and Integration in which Confidence is highest in cases where videos and words most obviously could or could not be integrated. Thus, temporal shifts would not necessarily change

overall levels of Confidence so the lack of such shifts is not significant. The strong R square of 0.791 for a linear regression of Confidence for all Delay States in experiment two compared with Confidence in experiment one indicates that the U-shaped relationship was confirmed.

Latency scores were different in experiment two from experiment one. The mean scores for the synchronized Delay State were nearly 0.5 seconds shorter than in experiment one, while the scores for all Delay States were comparable to the scores in experiment one. The Integration Latencies had an R square of 0.419 between experiment one and experiment two in synchronized state, but the R square dropped to 0.206 between experiment one and experiment two with all states. The relationship is no longer significant at the 0.01 confidence level. This does not necessarily mean that the relationship does not exist, but that it is uncertain. The Confidence Latencies were not significantly related.

In short, the Integration and Confidence score results of experiment two replicated experiment one showing the inhibiting effect of Delay States on integration. Confidence Latency results also replicated experiment one, though the introduction of Delay States reduced the closeness and eliminated any apparent relation in Confidence Latencies.

Primary Interactions. We begin with Integration – the integration of video and words into a single intelligible unit – and the factors that may affect it. One-way ANOVA's were run using the variable Delay State, which defines Delay State in nine categories as the independent variable with Integration, Integration Latency, Confidence,

Confidence Latency, Ease, Ease Latency, Content and Content Latency as dependent variables.

Table 4.12 shows the effect of Delay State on the dependent variables comprising subject performance. Delay State had significant associations with only two dependent variables: Integration, and Integration Latency. Integration was most likely in the synchronous 0 State, with a score of 1.48. It rose sharply even with a 1 second delay in either video (1.57) or words (1.58). Highest scores were for 1 second overlap and 1 second gap. Scheffé homogeneous groups analysis indicated two overlapping groups with group 1 being no delay and 1 second delay, and group 2 being all delays. The measured differences between delay groups were not statistically significant.

Table 4.12. Effect of Delay State on Integration, Confidence, Ease, Reaction, and Latencies

Delay State	Integration	Integration Latency (msec)	Confidence	Confidence Latency (msec)	Ease	Ease Latency (msec)	Content	Content Latency (msec)
0	1.48	2114	2.39	1379	3.66	2272	3.13	1683
1	1.58	1975	2.42	1323	3.69	2225	3.07	1825
2	1.65	1946	2.41	1491	3.60	2255	2.94	1710
3	1.65	2004	2.40	1479	3.63	2228	3.09	1729
4	1.63	1990	2.43	1416	3.68	2290	3.02	1798
5	1.57	1845	2.49	1436	3.79	2167	3.16	1791
6	1.62	1623	2.36	1454	3.63	2442	3.04	1750
7	1.60	1685	2.40	1391	3.59	2260	3.04	1749
8	1.59	1765	2.41	1401	3.67	2207	3.14	1751

Delay State had relations at the 0.01 level to only two dependent variables: Integration and Integration Latency. Multiple comparison tables using a Scheffé homogeneous

groups analysis showed two clusters or groups: Delay States 0 and 1 (synchronized and 1 second delay) and Delay States 1-8 (all states of delay). The relation between Delay State and Integration Latency was also non-linear. The significant differences were between Delay State 0, or synchronized, and Delay States 6 and 7: 1 second overlap or no overlap with words first. In short, the effect of Delay State on Integration was the same whether words or videos were first, but Integration latencies were lower where words were presented first.

To clarify measurements, Delay State was recomputed into two derivative variables reducing the number of cells and isolating the potential effects of the temporal delay and which mode was first. The variable Delay was created to indicate the amount of delay regardless of mode precedence, while the variable Precedent concerned only which mode was presented first (see Table 4.13).

Table 4.13. Variables Delay and First

Variable	Values
Delay	0 = Synchronized 1 = 1 second delay 2 = 1 second overlap 3 = No overlap 4 = 1 second gap
First	0 = Synchronized 1 = Video first 2 = Words first

A one way ANOVA was run for Delay with other variables. Delay was again significantly related only to Integration and Integration Latency. Scheffé homogeneous groups analysis indicated significant differences between state 0 and the cluster of states 2, 3, and 4, with state 1, the 1 second delay in the middle, not significantly contrasting with other Delays.

In the ANOVA of delay and Integration Latency, Scheffé homogeneous subset analysis confirms that the major difference is between state 0 and other delay states, indicating that any delay inhibits the tendency to integrate and reduces integration latency. Moreover, the effect is substantial with even a 1 second delay (see Table 4.14).

Table 4.14. Effect of Delay on Integration, Integration Latency

Delay	Integration	Integration Latency
0	1.48	2114
1	1.57	1910
2	1.63	1785
3	1.63	1845
4	1.61	1877

One way ANOVAs using Precedent indicated that it is Delay, not mode precedence that inhibits Integration but Integration Latency is lowest where words are heard first. Subject judge integration more quickly with words first than with video first or with video and words synchronized. This drop in latency occurs independent of any inhibition of integration (see Table 4.15).

Table 4.15. Effect of Mode Precedence on Integration, Integration Latency

Precedence	Integration	Integration Latency (msec)
Synch	1.48	2114
Video	1.63	1979
Words	1.60	1729

In short, Delay inhibits Integration and reduces Integration Latency. Precedence of words has no independent effect on Integration when controlled for Delay, but it reduces Integration Latency. This indicates the possibility of a different variable at work.

Results: Delay and Precedent. In these movies, there was no one-to-one correspondences between spoken words and videos (either sensory or conceptual), as there would be if, for example, the video showed a speaker talking as his or her words were being played or if when an item were mentioned it immediately appeared on the screen. These movies were more like footage with narration. Thus, the exact synchronization of video and spoken text had no a priori significance. A delay of one mode merely altered already arbitrary adjacencies of words and video. Nevertheless, Delay inhibited integration.

There are a number of possible interpretations for the potency of Delay. For example, factors might include:

1. The belief that video and words are out of synch causes subjects to attempt to link current events in one mode with past events in the other.

2. There may be two different and incompatible types of processing: processing for one mode and processing for two modes.

The lesser effect of a 1 second delay indicates the ability to withstand delays within a perceptual time frame such that the subject is not trying to recollect one event while experiencing another. Short term retention is dependent on both the time delay and the number of events taking place.[56] The ideas of cognitive interference from processing two different streams simultaneously and memory limitations are also consistent with the effects of higher delays: that integration improves when the video and words do not overlap and degrades when there is a gap between them of 1 second. These comments are speculative and point toward possible future research.

The effect of Mode Precedence adds another aspect. Precedence did not affect Integration but it did affect Integration Latency. Subjects resolved Integration more quickly when words preceded video than when video preceded words. They were slowest for simultaneous presentation. Since attribution is primary in language, it may be that language was used to form a quick initial interpretation. If so, that initial verbal interpretation did not result in greater likelihood of integration across mode. This is also speculative and points to further research.

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[56] Klatzky, R., Human Memory, Structures and Processes, W.H. Freeman & Company, New York, pp. 26-44, 1975

Affective Measures. Ease, Confidence and Content Reaction were highly related to each other, forming a cluster of "affect" variables. Ease and Content Reaction responses were difficult to distinguish from each other. They varied linearly with respect to each other and were similarly related to other variables. They were both also related to Confidence (see Table 4.16).

Table 4.16. ANOVAs of Ease, Content Reaction, Confidence

A. Ease, Confidence, Content

Ease	Mean Confidence	Mean Content Reaction
1	2.05	1.72
2	2.21	2.38
3	2.34	2.81
4	2.43	3.16
5	2.60	3.71

B. Content, Confidence

Content Reaction	Mean Confidence
1	2.28
2	2.30
3	2.37
4	2.43
5	2.78

Subjects reported cognitive Ease on a 5 point continuum from very difficult (1) to very easy (5). One-way ANOVAs were run with Ease as independent variable. Ease had significant relations with Integration, Confidence, Ease Latency, Content, and Content Latency (see Table 4.17.).

The relationship between Ease and Integration was essentially linear (see Table 4.18). It also linearly corresponded to Confidence. An ANOVA of Content by Ease indicated that all value differences were significant, while Table 4.18 indicated a one-to-one corre-

spondence between their values, i.e., that ease value 1 corresponded to content value 1, ease value 2 corresponded to content value 2 and so forth.

Table 4.17. ANOVAs for Ease

Dependent Variable	df	F	Sig
Integration	4	36.09	.000
Integration Latency	4	2.612	.034
Confidence	4	32.78	.000
Confidence Latency	4	2.306	.056
Content	4	189.6	.000
Content Latency	4	6.265	.000

Table 4.18. Ease Related to Integration, Confidence

Ease	Mean Integration	Mean Confidence
1	1.89	2.05
2	1.73	2.21
3	1.67	2.34
4	1.54	2.43
5	1.49	2.60

One surprising aspect of the relations is that ease managed to be linearly related to both Integration and Confidence, even though confidence and integration were not line-

arly related to each other See Table 4.19). Thus, Ease captured an affective aspect of the relationship between confidence and integration.

Table 4.19. Content Reaction, Mean Integration, Mean Confidence

Content Reaction	Mean Integra-tion	Mean Confidence
1	1.77	2.28
2	1.68	2.30
3	1.69	2.37
4	1.42	2.43
5	1.36	2.78

Content Reaction was similarly related to Integration and to Confidence, though the inter group relations were not as linear (see Table 4.20). In the relationship between Content and Integration, homogeneous groups analysis indicated two clusters (see Table 4.21). Negative and neutral Content reactions (1-3) formed cluster 1, while positive Content reactions (4, 5) formed cluster 2. In the ANOVA of Confidence by Content, homogeneous groups analysis disclosed three overlapping clusters (see Table 4.23). Negative Content reactions (1 and 2), weak reactions (2, 3, and 4) and strong positive reactions (5) were the three clusters. Their relationship to Integration Latency, the most objective measure of cognitive work was equivocal.

Table 4.20 ANOVA for Content

Dependent Variable	Degrees of Freedom	F	Sig
Integration	4	66.939	0.000
Integration Latency	4	4.714	0.001
Confidence	4	32.575	0.000
Confidence Latency	4	6.093	0.000
Ease	4	195.187	0.000
Ease Latency	4	41.788	0.000

Table 4.21. ANOVAs for Integration and Latency by Content: Homogeneous Groups

Content	Integration Homogeneous groups		Integration Latency Homogeneous groups	
	1	2	1	2
1		1.77	1854	1854
2		1.68	1892	1892
3		1.69		1968
4	1.42		1817	1817
5	1.36		1711	
Sig	0.382	0.089	.164	.341

Table 4.22. ANOVAs for Confidence and Latency by Content: Homogeneous Groups

Content	Confidence Homogeneous groups			Confidence Latency Homogeneous groups	
	1	2	3	1	2
1	2.28				1517
2	2.30	2.30			1461
3	2.37	2.37			1456
4		2.43		1362	1362
5			2.78	1266	
Sig	0.463	0.100	1.000	0.512	0.074

Table 4.23. ANOVAs for Ease and Latency by Content: Homogeneous Groups

Content	Ease Homogeneous groups					Ease Latency Homogeneous groups		
	1	2	3	4	5	1	2	3
1	2.79						2377	2377
2		3.24						2516
3			3.55				2363	2363
4				4.03			2174	
5					4.72	1640		
Sig	1.00	1.00	1.00	1.00	1.00	1.00	0.100	0.350

In experiment one, integration latency emerged as an important non-subjective measure of cognitive work involved in the interpretation of a movie. ANOVAs indicated that both ease and content were related to integration latency on the 0.01 level. The content based derivative measures strength and Positive-Negative were also related at the.01 level. Homogeneous subsets analysis indicated that there were two overlapping clusters for content: all but no reaction and all but high positive reaction (see Table 4.24). There may have been a combination of two effects here: 1) aversion to negative reaction as distinct from positive reaction, and 2) indifference or null reaction as processing difficulty, i.e. there was no reaction because the movie was hard to understand as indicated by the higher latency.

Table 4.24. Effect of Content Reaction, Strength, Pos-Neg on Integration Latency

A: Content, Integration Latency

Content Reaction	Mean Integration Latency
1	1854.7765
2	1892.2847
3	1968.1642
4	1817.5385
5	1711.2869

B: Strength, Integration Latency

Strength	Mean Integration Latency
.0000	1969.2956
1.0000	1855.2171
2.0000	1770.2077

C: Positive-Negative, Integration Latency

Pos-Neg	Mean Integration Latency
-1.0000	1882.7222
.0000	1968.1642
1.0000	1774.8980

Consistent with that view, Integration Latency dropped linearly with strength. When Integration Latency is graphed against Positive-Negative reaction, it was highest for

no reaction, but higher for negative reaction than for positive reaction. Thus we may have been seeing both effects: aversion to negative reaction and no reaction as cognitive difficulty. Of the two, lack of reaction was a stronger indicator of latency.

Confidence scores reinforce this view. Confidence increased linearly from negative through neutral to positive reaction. Each was significantly different from the others at the.01 level. The relation of Strength to Confidence has two clusters, no reaction and weak reaction form one cluster, while strong reaction has a higher confidence (see Table 4.25).

Table 4.25. Effect of Positive-Negative Reaction, Reaction Strength on Confidence

Independent Variable	Mean Confidence
Positive-Negative Reaction	
Negative	2.30
Neutral	2.37
Positive	2.57
Reaction Strength	
Neutral	2.37
Weak	2.37
Strong	2.57

Results: Affective Measures. With respect to initial hypotheses, the rate of integration did drop with delays, but delays did not increase. They actually decreased, particularly when words preceded videos. It is hard to say whether affective reactions changed globally, but they were most clearly reactions to perceived cognitive success.

Content reactions were primarily not reactions to content but, like ease, to cognitive success.

Affective measures were strongly related to each other. Experiment two presented two types of cognitive difficulties at the same time: semantic and sensory. They may interact. Reports of cognitive Ease actually duplicated reports of Content reaction and both were very dependent on an apparent desire to make a judgment and to form a single, integrated cognitive object if possible.

In short, subjects seem to have been reacting most strongly to the situation as a test and seek integration as a goal. The set of cognitive challenges introduced by delays may have caused this effect. If so, we might find the same effects in other situations in which there are multiple challenges, i.e. it may not be that this experiment is a test, but that a situation with the features of this one will be treated in the same ways that tests` are treated.

Part 2: Description

In the second part of experiment two, all movies were re-shown to subjects. After each movie, subjects were tested on their memory. The strategy was to show one of the two modes of a particular movie, either the video or the spoken words as a cue to that movie, and to show the other mode from four movies including the particular movie to be cued (see Figure 3.2). Subjects were asked to correctly match video and words of the movie In this way, either video or spoken words could serve as a cue for the recollection for the other. Thus, it might be possible to detect which movies were remembered, and whether video or words were better mnemonics. This method parallels research designs on memory in paired associate learning and an extensive literature on patterns of recol-

lection.

Major Hypotheses

The following hypotheses were tested:

1. Memory of integrated movies will be higher than on non-integrated movies. Cognitive association and pattern detection (sensory or conceptual) binds memory.
2. Memory will be associated with confidence. Confidence is an indicator of successful processing or forging of associations. Insofar as confidence is associated with cognitive ease, however, it may be negatively associated with memory.
3. Memory will increase with affective reaction (positive or negative). Affective reaction indicates greater depth of processing: i.e., that the subject has integrated the movie to the extent of having a judgment about it.
4. Memory will decrease with cognitive interference. Delay states will inhibit memory.
5. Memory will increase for successfully integrated movies where there is cognitive interference. If subjects are able to integrate movies despite the interference of temporal delays, their memories of those movies will be improved.

Frequencies. All movies were shown, after which there was a tutorial for the review part and then, movies were re-shown. As a result the average elapsed time between the first and second showing of a movie was 2,906 seconds (10 min. 36 sec), the minimum time was 178 seconds (2 min.58 sec), and the maximum time was 1,389 seconds (23 min. 9 sec).

Table 4.26 lists frequency statistics for part 2 variables. The overall rate of Memory, as indicated by correct matching of video and words, was 86 %. The failures include 98 trials in which no response was made within the maximum time or 20,000 Msec or 20

seconds. The mean Memory Latency was 8,150 msec with the maximum at 20,000 msec. If those trials were removed, Memory would increase to 89% and the mean latency would drop to 7,669 msec.

Table 4.26. Review Variables: Descriptive Statistics

Measures		Variables			
		Correct Answer	Review Latency	Review Confidence	Review Confidence Latency
Mean		0.86	8150	2.55	1522
Median		1.00	6933	n.a.	1350
Minimum		0	1150	n.a.	0
Maximum		1	20000	n.a.	8900
Percentiles	25	1.00	4766	n.a.	1100
	50	1.00	6933	n.a.	1350
	75	1.00	10466	n.a.	1766

In this experiment, Failed trials were included. Elsewhere in this experiment and the first, failures to respond (Fail) within times allowed disqualified those trials, but in this case it was more appropriate to include them. The Fail rate for identification and confidence questions was under 0.5% and there was no information entered. In this case, the Fail rate was 4%, which is material, and there is a clear interpretation. Both an incorrect match of video and spoken words, and the inability to make a match of video and words are errors: failures to remember the movie.

Thus, Fails were grouped with other incorrect matches. They were given latencies of 20,000 msec or 20 sec, which is the maximum time allowed for responses programmed into the experiment and the point at which the computer proceeded to the next trial.

The problem of identifying from memory was different from the initial job of integration; it took much longer and was subject to much grater variation indicating a multiplicity of factors affecting it. Review Latency was the time required to match video and spoken text, whether correctly or incorrectly. The Mean Review Latency was 8,150 Ms msec with a minimum of 1,150 msec and a maximum of 20,000 msec. Review latencies reflected the difficult cognitive job of matching the correct video or words from multiple sets as they are being shown. Thus, it involved memory, and discrimination between memories in a situation of cognitive interference stemming from multiple simultaneous sources of information being presented.

The mean Review Confidence was 2.55, higher than for initial integration. This is consistent with the idea that the job of identifying the correct answer reflects less interpretation than integration, and the high level of correct answers: most of the calls were easy.

To Summarize, there were no results that were anomalous or in contradiction with experiment one. The most striking finding was that the rate of Memory was so high, i.e. 85% of movies were correctly identified: 25% would be correctly identified by chance. Second, the cognitive problem of finding the correct match (Memory) is substantially different from integration question. It is much greater and more complex. Thus, the average latency was much greater and the range of latencies was also greater.

Part 2: Results

The primary hypotheses concerned memory and the factors that might affect it. The relations between memory and Integration, Confidence and Ease were all related to memory.

The relations between memory and the various other factors were determined through a series of one-way ANOVA's with memory as dependent variable. They also included cross tabulations to investigate possible intervening variables. They were specified to detect both linear and quadratic relationships. Where the independent variables were continuous, they were categorized for ANOVAs using quintiles to show linear and quadratic (U-shaped) associations.

As before, unless otherwise specified, relations described as significant were significant at the 0.01 level of significance (99% confidence that the result is not possible by chance) according to Scheffé tests as available within the SPSS statistical programming package. Relationships at or near the.05 level of confidence are noted as "possible", or "suggestive". ANOVA's require the generation of multi-celled tables and it may be that there are insufficient populations in some cells for accurate statistics. In those cases the lack of statistical significance does not necessarily indicate a null hypothesis, just an improvable one. Tables and graphs were generated in SPSS or redrawn from SPSS.

One important finding has special implications in terms of statistics. Integration was a powerful intervening factors: i.e., a number of factors were found to operate differently in integrated movies than in not integrated movies. Memory rates for integrated movies were so high that the populations of incorrect identifications were small, and the differ-

ences between them that were generated by independent variables, e.g., Delay, were too small to measure. Also, fewer movies were integrated than not integrated. Thus, while the differences between rates of memory for integrated and not integrated movies were clear, and differences between groups on not integrated movies were often significant, it was often not possible to demonstrate inter-group differences in the population of integrated movies because cell populations were too low.

Integrated movies were more often remembered than not integrated movies. Of integrated movies, 93% were remembered (7% were forgotten) while for not integrated movies, 83% were remembered (13% were forgotten). This was consistent with the idea that successful integration is mnemonic; people remember what they understand.

There was little or no relation overall between Integration Latency and Memory. In experiment one, Integration Latency was a strong predictor of Integration. The one-way ANOVA of Table 4.27 indicates a possible quadratic relationship (.025 confidence level).

Table 4.27. Linear and Quadratic Relations Between Integration Latency and Memory

		Sum of Squares	df	Mean R Square	F	Sig.
Linear Term	Unweighted	.193	1	.193	1.629	.202
	Weighted	.194	1	.194	1.636	.201
Quadratic Term	Unweighted	.594	1	.594	5.014	.025
	Weighted	.596	1	.596	5.028	.025

This result stands in contrast to expectations raised by experiment one where integration latency emerged as a good indicator of cognitive work, but the cluster chart of Figure 4.3 shows that integration delay may operate differently in integrated movies from not integrated movies. Scheffé homogeneous groups analysis did not yield a 0.05 confidence level, so it was not possible to draw firm conclusions about the shapes of those relations. This can also be seen via the error bars showing the intervals for 0.1 confidence levels.

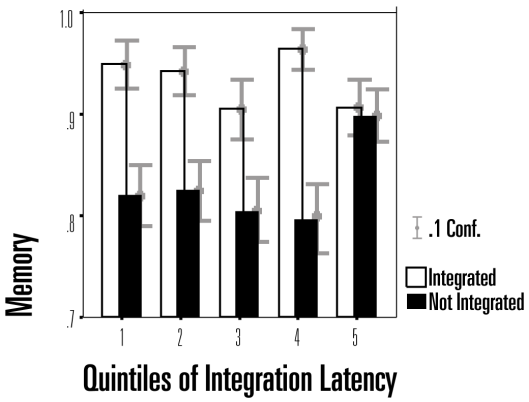

Figure 4.3. Memory by Integration Latency for Integrated and Not Integrated Movies

Thus, either Integration Latency is a less good predictor of cognitive work, which would not be surprising given the variability of the matching task which it reflects, or cognitive work is a weak predictor of memory. Given the variability of the matching task and other results indicating a strong association between cognitive work and Memory, the reasonable interpretation is that the variability of the matching tasks masked cognitive work effects.

The nine category variable Delay State per se was not significantly related to memory (see Table 4.28), possibly because of the number of cells involved in the statistic. The five

category measure Delay (regardless of which mode has precedence) had no relationship to memory for integrated movies, but here was a relationship for not integrated movies. As Figure 4.4 shows, the measured differences in Memory were smaller than the error ranges of those measurements for integrated movies, but not for Not Integrated movies.

Table 4.28. ANOVA, Effect of Delay States on Memory

Correct Answer		Sum of Squares	Mean R Square	F	Sig
Between Groups	Combined	0.859	0.215	1.806	0.125
Linear Term	Unweighted	0.432	0.432	3.636	0.057
	Weighted	0.433	0.433	3.644	0.056
Quadratic Term	Unweighted	0.321	0.321	2.697	0.101
	Weighted	0.320	0.320	2.696	0.101

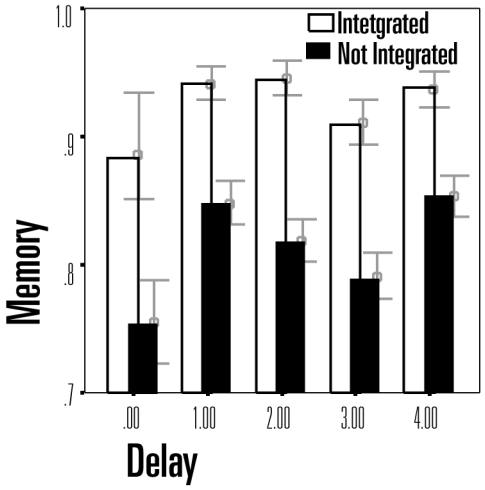

Figure 4.4. Delay and Memory for Not Integrated and Integrated Movies

Table 4.29 summarizes the ANOVA for Memory and Delay State. Homogeneous group analysis indicated two overlapping clusters in the relationship between Delay and Memory for Not Integrated movies: all delays, and Delays 0, 2, and 3 (see Table 4.30). The level of significance was 0.06, so the data is suggestive but not statistically significant.

Table 4.29. ANOVA for Memory by Delay for Not Integrated Movies

Correct Answer		F	Sig.
Between Groups	Combined	3.035	.017
Linear Term	Unweighted	3.114	.078
	Weighted	1.364	.243
Quadratic Term	Unweighted	.378	.539
	Weighted	.024	.877

Table 4.30. Homogeneous Groups of ANOVA for Memory by Delay for Not Integrated

Delay	Homogeneous Groups	
	1	2
.00	.76	
1.00		.85
2.00	.82	.82
3.00	.79	.79
4.00		.85

Mode precedence also had no significant relation to memory (see Table 4.31). While

there may have been some difference (significance 0.06) between synchronized and non-synchronized movies, the memory for video first and words first presentations was almost precisely the same. As above, memory was higher when there is delay.

Table 4.31. ANOVA of Effect of Mode Precedence on Memory

Correct Answer			F	Sig.
Between Groups	Combined		2.505	.082
	Linear Term	Unweighted	3.887	.049
		Weighted	1.539	.215
	Quadratic Term	Unweighted	3.472	.063
		Weighted	3.472	.063

In short, the non-subjective measures other than integration were unrelated or only weakly related to memory. A more refined experimental procedure, either in experiment design or statistical analysis, would be needed to make an accurate assessment of how those variables are operating.

As shown by Figure 4.5, the association of Confidence and Memory were very different for those movies that were integrated than for those that were not. There were no significant inter group differences for integrated movies. For those that were not integrated, the most significant relationship (.000) with Confidence was quadratic: i.e. the U-shaped curve, while the secondary relationship (.002) was the linear improvement for greater Confidence. Highest memory was for moderate confidence with lower memory for high confidence and lowest memory for low confidence. This is again compatible with an in-

terpretation of retention enhanced by the cognitive difficulty of acquisition. The effect was measured at the 0.01 level of significance.

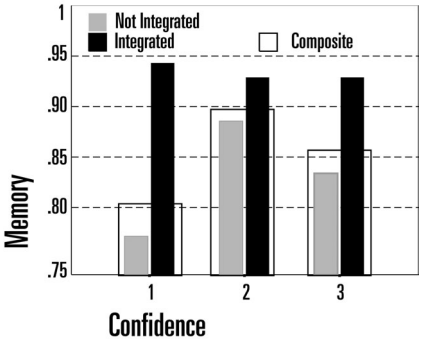

Figure 4.5. Confidence and Memory

For integrated movies, Memory was high and consistent. For example, where movies were not integrated, mean Memory rates according to Confidence varied 11%, from 76% to 88%, while for integrated movies, they ranged only about 1%, from 92.5% to 93.8%. In short, in this experiment, Integration was effective in binding memory of movies regardless of Confidence.

In short, affective measures like Confidence, and Integration may point to alternative methods, i.e. that integration is mnemonic, as is the detection of some other pattern that satisfies cognitive needs.

As discussed in part 1 of this experiment, Ease and Content were closely related. They were substantially affected by Integration. The mean Ease dropped from 3.95 for Integrated movies to 3.46 for not integrated movies and the mean Content dropped from

3.46 to 2.84, i.e. from a positive to a negative reaction. These both appear to be reports of perceived cognitive difficulty or success, rather than of content reaction per se.

The asymmetry between not integrated and integrated movies observed with respect to Confidence could also be observed with respect to Ease (see Figure 4.6). Ease and Memory were significantly related where movies were not integrated, but as the graphs indicate, the significant relationship was between the greatest difficulty (value 1) and all other values (see Table 4.32). The most difficult movies were least likely to be remembered. In integrated movies, the scores were not significantly different. The high score shown for category 1 among integrated movies shown in Figure 3.9 was based on only 12 responses thus it is suspect.

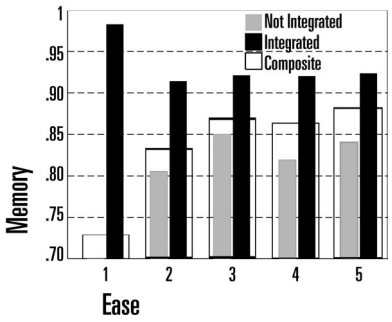

Figure 4.6. ANOVAs of Memory by Ease

These results are also consistent with the results based on confidence, i.e. that while cognitive work may bind the memory of not integrated movies, there are limits to the memory improvement it can effect. If the purpose of cognitive work is to bind experiences on some level: conceptual, narrative or sensory pattern, it may be possible to bind

not-integrated movies on a sensory pattern level, but if there is no discernible pattern, cognitive work becomes ineffective.

Table 4.32. ANOVA of Ease and Memory: Homogeneous Groups

Ease	Group 1	Group 2
1	0.73	
2		0.83
3		0.86
4		0.87
5		0.88

A similar asymmetry can be seen with respect Content (see Figure 4.7). Where movies were not integrated, negative reactions were associated with lower Memory while positive reactions were associated with higher Memory. The same effect could be observed for integrated movies: i.e. a positive association between positive content reaction and memory. It was significant in both cases. The difference between 75% and 85% memory is a decrease of 45% in forgetting and the difference between 89% memory and 94% memory is also a decrease of 45% forgetting. Here, again, Content appears to have been more a reaction to the job of making sense than of the content being interpreted: a reaction to process rather than result.

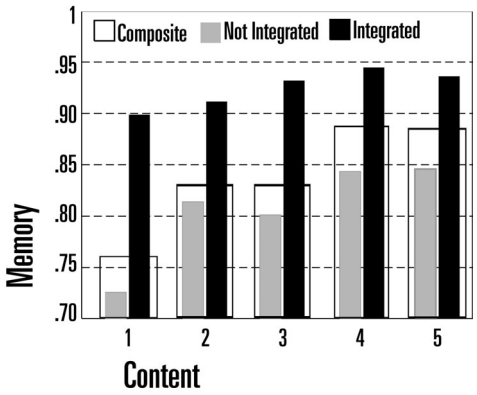

Figure 4.7. Memory by Content for Not Integrated and Integrated Movies

In short, of the factors discussed so far – those relating to the original presentation of movies – Integration was the most important. Movies were best remembered when they were integrated. The other measures: Confidence, Ease, and Content were relevant to not integrated movies but had little effect on memory for integrated movies. They operated as if two types of mechanisms were involved in the same job of binding memory: 1) the identification of a coherent whole, and 2) the identification of patterns. Either could bind memory. The former was rapid and certain, while the latter was a fall-back requiring more cognitive work. Affective measures can be understood as reactions to the cognitive work and success of interpretation.

Review Presentation Variables. The last set of factors to be discussed are the cues for memory: Video or Words. In the review section, the methods of presentation presented a number of discrete cognitive challenges and variables that may be related to memory (see Table 4.33). The major question was whether movies are remembered according to their video or their words. Differences between modes in the potencies of their cues would indicate how movies are remembered.

Table 4.33. Experiment Two: Review Variables

Review Presentation Variables		
Variable	Data	Measures
Memory	0 = Incorrect 1 = Correct	Memory for a Movie: means or rates of correct answers as related to other variables
Review Latency	Milliseconds	Latency for making a correct or incorrect Memory answer
Video or Words (VorW)	1= Video cue for words 2 = Words cue for video	In which mode was the memory item presented to be correctly matched
Review Confidence	1 = low 2 = Medium 3 = High	Reported confidence in having the correct answer
Review Confidence Latency	Milliseconds	Time required to indicate confidence

The memory score was 91% for movies where words cued video and 83% where video cued words. Thus, it appears that words served as a better memory cue for video than video for words, but that result was confounded by the effect of Review Latency on Memory (see Table 4.34), which show that Memory and Review Latency were strongly related.

Homogeneous Groups analysis indicated that there were three clusters: slow to moderate latency, moderately high latency, and highest latency (see Table 4.35). For low and moderate latencies, Memory rates were similar, but they dropped off sharply as latencies rose

Table 4.34. ANOVA of Memory by Review Latency (quintiles)

Review Latency (quintiles)	Latency (msec)	Memory (%)	Scheffé Homogeneous groups
1	0 – 4316	98	1
2	4316 – 5983	96	1
3	5983 – 7916	94	1
4	7916 – 11300	85	2
5	11300 – 20000	61	3

Table 4.35. Review Latency and Mode of Memory Cue

Review Latency (quintile)	Word Cue (%)
1	76
2	61
3	49
4	42
5	27

It took longer to process with video cues than with word cues. As shown by Table 4.35, 76% of the fastest processed videos used spoken word cues to video, while 73% of the slowest processed movies used video cues to words.

Once the effects of latency are removed, memory rates for Video or Words as cues dropped below statistical significance. Figure 4.8 shows a consistent relationship between

review latency and rate of memory for both video and word cues. Either way, the longer was the latency, the lower was the rate of memory.

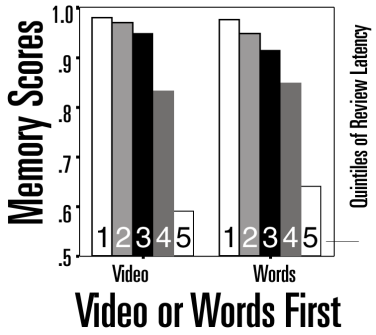

Figure 4.8. Review Latency and Memory with Video or Words as Memory Cues

Findings and Discussion

To Summarize results of part 2, Memory rates ranged from 70% to 95%. Integrated movies had Memory rates ranging from 90 to 95% while not integrated movies had memory rates ranging from 72% to 90%. For Integrated movies, rates of memory were consistently high, while for Not Integrated movies, Delay was the major determinant of memory through integration, i.e. movies that were not integrated were not remembered. Delay inhibited Memory by inhibiting Integration. At the same time, among those movies that were Not Integrated, Delay by itself improved Memory. The lowest memory scores were for movies that were not integrated and had no Delay.

Ease and Memory reflected integration, and were not independent of it: i.e. people reacted positively to movies they could interpret rather than interpreting what they liked. Variables operated differently for integrated movies than for not integrated movies. Integration Latency and Affective self-reports such as Ease and Correct were not related to

Memory within integrated movies, but were related for not integrated movies:

1 Memory is highest for medium Confidence.

2 Memory is somewhat higher for movies rated high in Ease of processing.

3 Memory is higher for movies given Positive Content Reactions.

Finally, in looking at Video or Word Cues and Memory, the most important variable was Review Latency. There may be differences in recall when cued by Video v. Words, but such differences were eclipsed by the effect of Review Latency itself. The longer it took subjects to match or mismatch videos and words, the more likely they were to be incorrect. This effect began to be felt near 6 seconds and rapidly increased for longer latencies.

These results are again consistent with a theory of interference, i.e. the cognitive difficulties that inhibit one task (e.g., integrating a movie) facilitate the next task (e.g., remembering it). Thus, it could be that the cognitive work of which review latency is indicative could be found facilitating some subsequent task.

Put another way, the lowest scores for Not Integrated movies with 0 Delay were for movies in which the inhibitions to integration were purely semantic, and not sensory. The results indicate that reactions to semantic difficulty are different from those of sensory difficulty. The memory of semantically difficult movies may be increased by the introduction of sensory challenges like temporal shift.

To summarize major findings:

1 Memory of integrated movies is higher than for not integrated movies.

2 Memory increased linearly with Ease and Content reaction.

3 Cognitive work had little effect on memory of integrated movies

4 Cognitive work was most effective for not integrated movies.

5 Delay states inhibited integration but facilitated later memory.

CHAPTER V

CONCLUSION

The goal of this dissertation has been the establishment of a theoretical foundation and method for studying communications that is of relevance to communication designers. It sought theory and methods that could be used to operationally examine and define material characteristics of communications that can predictably affect their reception across populations. This dissertation has been concerned with finding non-idiosyncratic aspects of human reception: factors which operate across individuals, and which can be measured and applied in the design of communications.

The dissertation proposed to operationally define reception in three interrelated variables: retention, comprehension, and interpretation. Each of these was understood as a measurable association between items in a communication reflecting processes of integration and segregation by which people organize experience into discrete items and events. Retention indicated the fact of retention and its stability, comprehension indicated the synthetic level and depth of retention, and interpretation indicated the configural pattern of association: the qualitative aspects of memory.

Put briefly, this dissertation asserted that the associative links by which we, as humans, remember things define the ways in which we can think about them, thus memory and its associations constitute interpretation. Defining reception in terms of memory is appropriate to design methods that manipulate material aspects, and design goals of

memorability and predictable interpretation. It avoids the problem of confusing identification with subjective evaluation, and of confusing reception with verbal self-reports.

Constructing reception in terms of cognition forces consideration of the closeness of perception to conception, and the possibility that, contrary to rationalist preconceptions, conceptual linkages are inferred from perceptual proximities.

Attribution theory expresses the ideas 1) that the perception of something is a semiotic naming process or "seeing as" that entails speculatively assigning specific constituent characteristics and discourses to it, and 2) that the grounding of such naming is not in proof, but in coherence and functionality of later behavior. Attribution theory takes this constructivist position and asserts its inevitability in material existence, as demonstrated by rhetorical practices like communication design, that seek to construct interpretations by manipulating perceptual characteristics such as visual syntax and temporal adjacency.

Knowledge and Empiricism

This dissertation based design theory on an empirical and experience based notion of human communication and knowledge, i.e. that human knowledge stems not from a res cogitans, but from empirical experience as it is actually processed. Knowing is a kind of experience, corresponding to cognitive change in the individual confirmed by successful interaction, i.e. recognition and confirmed expectations.

Since knowing is a form of experience that occurs in space and time, and cognitive processes occur in space and time, then knowledge can be understood as the result of a procedure. Rhetoric describes this procedure. Thus, communication design is an exercise in the rhetoric: the construction of entities and events that will be found intelligible by

receivers. It is a process that "creates an object for consciousness that speaker and listener perceive."[57]

Cognition and Communication

This dissertation proposed cognitive procedures as a foundation for communication design, not as an alternative or competitor to signal or code-based theories but as a ground for them. It has argued:

1. Cognitive processes are logically prior to codes which result from them, and cognitive processes are always present as the methods by which codes are processed.
2. The codes themselves are alternative outcomes within the possibilities structured by cognitive processes.
3. Thus, cognitive processes can be used in communication to generate code systems (induce learning) and translate between them(communicate knowledge).
4. The communicative artifact itself, must simultaneously encode into its physical manifestations both the content of a communication and the keys for decoding it. Thus, the artifact operates both from the bottom up and the top down at the same time, like the words of a sentence that have specific meanings in the context of the sentence that they construct.

According to this basic position, diverse culturally transmitted code systems rest on common perceptual and cognitive bases so that communications can be constructed in terms of cognitive aspects or affordances. The material aspects of communications that designers manipulate interact with cognitive processes of receivers in ways that are less dependent on cultural knowledge than many cultural codes.

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[57] Lanigan, R., Phenomenology of Communication, Duquesne University Press, Pittsburgh Pennsylvania, 1988

Experiments

The experiments were intended to examine this general position by demonstrating the relevance or irrelevance of cognitive characteristics as measurable, causal factors in interpretation. They utilized mixed mode communications incorporating both video and spoken words with varying semantic relations and temporal relations. Materials were selected to avoid, insofar as possible, requiring specialized knowledge for interpretation. They use selected juxtapositions of sensory (video) and symbolic (words) modes because of their potential for cross-mode communication as bricolage or aggregate, defined as involving a disjoint cognitive process in which two sensory streams are not directly connected, but processed independently, then joined. There was no direct correspondence between events heard and seen in the movies presented. Each mode was independently interpretable and the combining of the two could imply a domain outside the domain of one or both alone.

Experiment One

Findings. The question explored in experiment one was whether the interpretation of movies made-up of such juxtapositions was idiosyncratic or consistent, and if evidence could be found of common cognitive processes. Several findings were very clear:

1. There is no such thing as unlimited semiosis: i.e., we do not have complete freedom in how we combine images and texts.[58] There were some movies that all or almost all subjects found interpretable and others that subjects found uninterpretable.

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[58] Eco, U., A Theory of Semiotics, Indiana University Press, Bloomington, Indiana, pp. 125-129, 1979

2. People experience similar common cognitive difficulties and processes. Latency or how long it took subjects to decide if the movies could be integrated, the average rate of integration and confidence clustered very closely together indicating that subjects consistently found the same movies ambiguous and difficult to interpret.
3. Cognitive processes are remarkably consistent for adults regardless of sex or education.
4. Differences in interpretation are less real than apparent. In movies where subjects were evenly split over whether they could be integrated or not, subjects had high latencies and low levels of confidence. Their different decisions did not represent different interpretations. They were more like different guesses.
5. Organizing data by movie shows major relationships between indices of integration, levels of confidence and latencies.
    a. Movies with high and low scores in integration were associated with equally high levels of confidence and equally quick subject responses.
    b. Medium integration scores were associated with low confidence and slow responses.
    c. Slow responses in integration were associated with slow responses in reporting confidence.
    d. Once integration responses were keyed in, confidence responses were made much more quickly.

6. Background Variables were related to some indices but not to the interrelations between indices.
    a. Sex was not significantly related to any indices.
    b. Older subjects were less likely to integrate movies and responded more quickly.
    c. Students were less likely to integrate movies, had somewhat lower confidence levels, and responded substantially more slowly.
    d. While subjects' background variables were related to differences in their rates of Integration, Confidence, and Latencies, the relations between these variables remained constant for all subgroups.

The experimental methods yield interpretable data. They are yet to be extended to research many different questions and build a body of knowledge about cross mode interpretation and memory.

Experiment One: Limitations and Further Research. Experimental movies were produced according to a four level classification of video-word relations: 1) common subject matter, 2) common explicitly represented concept, 3) common implicit concept and, 4) no reasonable concept linking. It was expected that integration would be greatest for group 1, successively less for groups 2 and 3, and least likely for group 4. Results were reasonably consistent with this scheme, though not fully.

The classification scheme used here is questionable in terms of its objectivity and repeatability. First, there was not a good set of operational specifications for each cell in the taxonomy. Movies were placed according to post hoc judgments rather than specifications by which they could be made. The taxonomy was also constructed on an empirical base. It was based on the notion of concept formation through analogy: i.e. that the video and words would suggest a conceptual analogy that subjects would grasp, and on the basis of which they would be able to integrate.

Anecdotal responses indicated a strong tendency toward narrative and attributive responses. For example, if a description of someone's temper accompanied video of a person being led into a police car, a description might be "It's about this guy who beat her up and she called the police." This evidence suggests the possibility of two successive levels of integration: 1) the integration into a narrative by making attributions across modes,

which might be followed later by 2) a more conceptual analysis, like "Here's what happened," and then, "Here's Why." This speculative possibility needs to be researched.

Experiment Two. In experiment two, the temporal relations between video and words were manipulated in order to investigate the effects of sensory variables on integration and memory. Here the results are substantially more complicated and involve a number of interactions between variables.

First, delay is an important variable affecting integration. Even though there was no one-to-one correlation between events on the screen and spoken words. It appears that subjects were as affected by the idea that there was a delay as the delay itself. The effect was independent of which mode is delayed, but the delay effects are indicative of the memory limits of perceptual registers, and interference effects of overlapping signals. It appears that a short delay of one second, which is within the memory limits of sensory registers, is not as inhibitory as a longer delay but the statistics were not conclusive.

Also suggestive but not statistically conclusive were slight drops in the inhibitory effects of delay when one mode followed the other without overlap or gap, and an increase when there was a gap. It may be either that subjects are attempting to use memory to re-synchronize words and videos or that they are faced with switching methods of interpretation from single mode linear to bi-modal bricolage. Further experimentation would be needed here.

With respect to integration latency, when spoken words were first, subjects respond much more quickly than if videos were first or if videos and words were synchronized. This effect was independent of delay and independent of integration. So it indicates that

something different was happening in the processing when words are first, though it did not affect the ability to integrate. One speculation could be that since text is attributive, the precedence of spoken words rapidly produces a set of attributions that are compared with videos, i.e. that the interpretation begins earlier. The statistical methods did not support more fine grained analysis so here, again, more research would be needed on these questions.

In experiment one, the self-report of confidence was very strongly related to integration and to integration latency (see Experiment one, Figure 17, 18). There was no such clear relation in experiment two. Sensory or temporal shifts swamp any relation between confidence and semantic relations between words and video. This may have been because of the simultaneous effects of cognitive work and integration, which is discussed below.

The self-reports regarding cognitive ease and reaction to content were primarily related to integration, i.e. the higher the rate of integration, the higher the reported cognitive ease and the more positive the reported reaction.

The responses to both questions asking how difficult movies were to interpret and the reaction to content should both be put in the context of the experiment itself. First, movies were not widely varied in terms of pleasantness-unpleasantness. Thus, it is possible that a variable reflecting content reaction would be demonstrable with a more varied or extreme group of movies.

There were indications of two variables at work affecting memory: integration and cognitive work. The most important variable affecting memory was integration. It indicates that subjects were more likely to remember what they understood. Between 5% and

8% of movies that were integrated were forgotten, less than half the rate of forgetting for not integrated movies. For integrated movies, other factors had little effect. But for not integrated movies, other variables indicating cognitive load had significant positive effects. Delays that inhibited integration facilitated memory, and high integration latency substantially increased memory.

These results point to the possibility that there are two alternative methods for binding memory: integration and cognitive work or effort to integrate. These results also point to the possibility of multiple levels of pattern recognition involved, and that while some fall short of full "integration" as judged by subjects, they are nevertheless adequate to bind memory. Again, affective reaction tracks memory indicating that it may be a reaction to cognitive success rather than to content.

Findings that cognitive challenges that inhibit integration can actually facilitate memory is compatible with results obtained from studies on intratask interference (Battig 66, 72), indicating that difficulty in acquisition may improve retention. One interpretation of this work stresses the role of the semantic structure or meaningfulness of items to be remembered while here the difficulty comes from sensory disruption.

Finally, it does not appear that either the visual or linguistic mode is a better mnemonic cue than the other when controlled for latency. The relative perception level demands of the two types of cues – listening to a spoken text and looking at four videos, v. looking at one video and reading four texts – are too different to be compared. Thus, we cannot say definitively that video or spoken text is a better cue. It can be said that either one can work. The important question for memory is how long the recognition process

takes. This can be interpreted in either of two ways. Since movies are 8 to 12 sec. long the steep drop-off after 10 sec. may reflect having seen or heard the movie in its entirety, or there may be a limit to memory or attention. If recognition is a perceptual effect, based on a cue or cues, then that cue may take place anywhere in the movie, the possibility of recognition should drop rapidly after the completion of the movie. Here again, more research would be needed.

Experiment Two: Findings. Experiment two demonstrates the following:

1. Perception and perceptual limitations are critical in cognitive integration. Perceptual disturbances substantially affect integration independent of semantic relations. Temporal shifts become substantial at or near the temporal limits of sensory memory.
2. Integration is critical in binding memory.
3. Where integration is not possible, there are alternative methods of binding as evidenced by levels of cognitive work.
4. Latency time is critical in memory by recognition. The longer it takes to remember something, the less likely it is to be remembered.

The findings cited here are limited by the methods and statistical analyses supported by the experimental design. Here are some of the questions raised by the experiments:

1. Is the taxonomy of semantic relations appropriate, or would a narrative based taxonomy be better?
2. What are the relative roles of attributive v. conceptual processing in integration and memory?
3. What are the possible roles of content and affective reactions to it in integration and memory?
4. What are the underlying cognitive factors reflected in the effects of delay?

5. Does delay amount to intratask interference causing intertask facilitation?
6. Are video cues more or less potent mnemonics than language cues?
7. If latency is critical for recollection, what are the mechanisms, and are they perceptual?
8. Are people processing according to narrative, by concept formation, or are they processing first by narrative, then conceptually?

It was not possible to answer these questions in the experiments. In some cases, investigation would entail analysis for multiple intervening variables and the population was not big enough to support such methods. In other cases, different experimental designs would be required.

Experiment Two: Limitations and Further Research. Especially in experiment two, findings were limited by the number of questions that could be answered in a single experimental situation. For example, relations between affective reaction and memory might have been demonstrable without the perceptual disturbances of the delays. Similarly, the choice of video and spoken text as modes of presentation facilitated latency measurements in the experiment but made the interpretation of delay effects far more difficult than it would have been had short texts and still images been used. One answer would be to split experiment two into a series of individually less complex experiments.

Future Directions

There are no direct experimental precedents for the experiments conducted here: i.e., cross-mode experiments using short multimedia movies to test integration or for manipulating such characteristics as temporal relations for their effects. As a result, many

experiment design decisions had to be made speculatively or on the basis of research which was only indirectly related to the experiments being undertaken. Thus, measures are not refined.

Accepting the validity of the basic experimental design, its specifications can be refined and extended in many ways.

1. Specific parameters like the lengths of movies, and specifications like the use of videos and spoken texts as distinct from images and written texts could be altered for comparison and for refinement. For instance, the lengths of movies and of delays could be altered or refined to differentiate the semantic and perceptual mechanisms involved. By the same token not everything in these experiments could be randomized. Further experiments could alter the numbers, order, and methods of asking questions to refine that aspect.
2. Other measures like timed galvanic skin response could be introduced to better measure reaction and differentiate affective responses to movies while they are being shown from responses to the cognitive jobs involved in answering questions about them.
3. This method could be used to examine a wide variety of variables including the use of still photographs, superimposition of text, video montage and quality, the speaker's age, race, sex, manner of speaking and tone of voice. Experiments could be extended to include associations between different movies and sequences of movies. It could be used to study the effects of photographic variables, sound, or music, and it could be used to access a broad variety of socio-cultural attitudes as they affect interpretation, comprehension and memory.
4. Methods could be extended to the domain of human-computer interaction and thus to the construction of human-computer activities and their design.
5. The experimental methods used here could be applied unobtrusively outside of the laboratory, in real-world situations and integrated into design processes.

The experimental method has demonstrated the validity of the theoretical approach based on cognitive function can be resolved into specific predictions and those predic-

tions can be tested. It has the potential for application as a method for gaining access to a broad range of variables through their affects on cognitive processes and the effects cognitive processes have upon them.

Application to Communication Design. The theoretical position and the research presented in this dissertation has direct implications to communication design on 3 levels: findings, theory, and meta-theory: i.e., a theoretical base that can be used to produce hypotheses regarding design practice.

It generates specific findings in the domain of communication design: practical advice for communication designers. Some findings may be surprising, such as the facilitating effects of interference.

1. It presents a theoretical model of communications that is testable: it can be used to make hypotheses that can be affirmed or refuted.
2. It builds an experimental method that can be used to generate and test new hypotheses and in that way to refine, extend and produce new models.
3. Using this procedure, it is possible to incorporate assessment into communications as they are being used.

Finally, this an integrated approach that provides an appropriate location for design: neither literary nor scientific, but constructivist. Design creates the material world of experience. This approach does not intend to replace the array of hermeneutic approaches to interpretation and replace them with a positivist model. It grounds hermeneutic approaches by demonstrating their reality, and by examining and applying them. It takes a step toward enabling communication design to become a theoretically informed, re-

search-based enterprise that can specify and design communicative outcomes and assess performance.

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