Semiosis and Sensory Cognition in Multimedia Communication

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Abstract:
A major problem for communication designers is the lack of operational approaches to the relationships between communication goals and the anatomies of communications themselves as signifiers. This failure leaves the process of communication design inaccessible. Communicators are left to speculate about the meanings and results of their strategies.

In particular, the increasing use of multimedia and interactive communications brings a need for the analysis of cross-mode semiosis. Multimedia are able to combine symbolic modes like text with sensory modes including images, motion, and sound. Psychological accounts like attribution theory indicate that modes like text and image are associated without accounting for how or when.

This paper describes a semiotic/cognitive approach to bridge the gap. It presents experimental research using cross-mode cognition to study variables affecting meaning making: integration, retention, and interpretation. The research methods provide a robust, repeatable, in situ method for exploring many different communication questions, and for extending empirically based theory

The position of this paper is that communications function by inducing and guiding the cognitive processes of receivers through the manipulation of the physical characteristics of the communications. These physical characteristics interact with cognition to produce interpretation. This theory grounds semiosis in species-wide cognitive processes and metaphors based on embodied experience.

The proposed cognitive process model is based on perception, cognitive work, and memory, which underlie the social and cultural code systems of communicative forms. First, cultural code systems are not to be studied as if self-contained, but as cognitive methods. Second, since perception and conscious thought are inextricably tied together, a cognitive process model links interpretation to material, experiential characteristics.

In support of this position, this paper presents research and findings using cross-mode cognition to study the following: 1) mode of communication, 2) semantic relations within communications, and 3) relative time and sequence of messages as they affect retention in memory, comprehension, and interpretation.

Introduction: Language & Cognition

In the discussion of meaning, we have entered an era of cognitivism in which the underlying explanations of language, visual perception, and social behavior are increasingly being found in the cognitive processes that underlie and work through them to construct reality.

In linguistics, victor Yngve demonstrates the extent to which spoken languages are grammatically compromised to accommodate human cognitive limits. According to Yngve, there is an observed maximum sentence complexity or recursiveness that accords with psychologists' findings on the capacity of working memory, i.e. seven plus-or-minus two.[1] Gilles Fauconnier puts it as follows:

> In the case of language, the domains that we need in order to understand language functioning are not in the combinatorial structure of language itself; they are in the cognitive constructions that language acts upon.[2]

Fauconnier's notion of cognitive frames or contexts, which he calls "mental spaces", and the logical calculations that take place within and between them operationalize the reasoning and meaning aspects of language. Mental spaces are semiotic. "[L]*anguage expressions reflect objective events and situations … through elaborate human cognitive constructions and construals* [structured by mental spaces]."[3]

Lakoff and Johnson[4] explicate the link from language to the sensory world of experience and cognition through the foundational importance of "base metaphors": semiotic tools with their origins in sensory experience. These metaphors are projected onto new domains as "idealized cognitive models."[5] Thus, the literal statement "the ball is in the cup" uses a notion of containment that can be applied to other domains: "Groningen is in the Netherlands," or "she is in school, in bed, in trouble.", etc. Such base metaphors bring with them ways of thinking; getting out of trouble is not the same as leaving it behind.

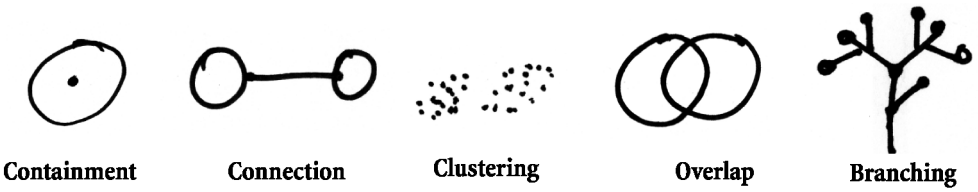


Figure 1: Gestalt Visual Relations

Gestalt psychology describes mechanisms of visual semiosis which organize sensory flow into discrete objects. These mechanisms produce the basic spatial and temporal forms of construal, i.e., of integration and segregation, such as containment, connection, clustering, overlap and intersection, choice or branching, etc (Figure 1). Gestaltism posits the holism of visual cognition, i.e. that it is the perceived whole or gestalt that determines our interpretation of parts rather than the parts that are assembled into the whole.

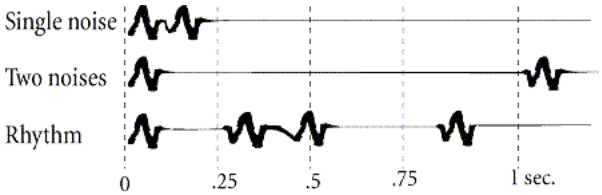
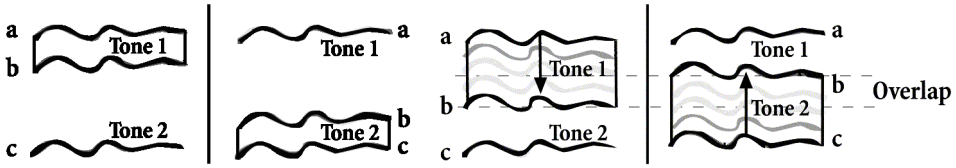


Figure 2: Diachronic Auditory Event Integration

Parallel observations have been made in aural phenomena. Albert Bregman, for example, elucidates auditory cognition as a process of segregation and integration of sound events by temporal proximity and tonal/timbale similarity (Figure 2).[6] Acoustic events which take place more than a second apart are typically heard as separate. If they take place less than one tenth of a second apart, the perception is of a single event. If the temporal intervals between events are between one tenth of a second and about one second, beats, tempos, and rhythms are heard. This effect also operates across modes. We may know that lightning and thunder result from a single event, but if the interval between them is much more than a second, we perceive them as separate.



Synchronic Segregation/Integration Precedence Effect in Integration/Segregation

Figure 3: Synchronic Auditory Event Integration

Gestalt auditory effects are synchronic as well as diachronic (Figure 3). For example, if three tones (a, b, and c) are played simultaneously, and a and b are close in frequency while c is distant, a and b will be heard as a single, albeit more "complex" tone. If b is closer to c than a, it will be integrated with c. If b begins close to a but its frequency is altered moving toward c, at some point the perceived valence will "flip" as a lets go of it and it fuses with c. Most interesting, once a tone cluster is integrated in one way, there is a

perceptual reluctance to change its organization. If tone b is first heard integrated with a, it will remain integrated with a until it is substantially closer to c, while if it is first integrated with c, it will remain with c until it is substantially closer to a. Thus, there is a region in which tone b will be perceived as integrated with a or c, depending on which it was integrated with at the outset. Once a specific configuration is cued, it is retained as a persistent idealized cognitive model, until it is so stretched that a new model must be found.

Thus, visual and auditory systems show parallel semiotic tendencies to spatially and temporally organize by integration and segregation, and to perceive change at the point when a gestalt is no longer tenable as an idealized cognitive model.

There has been lively discussion about the comparisons of and linkages between sensory and linguistic worlds. Views have ranged from Paivio's "dual code" model which argues that visual processing is distinct from that of language, to Pylyshyn's essentially linguistic or propositional view of perception. [7] On the level of experiment, Kosslyn enumerates five models of imagistic memory used in experimental study: purely imagistic, purely propositional, and mixtures either serial with imagistic or propositional modes occurring first, or with both modes operating simultaneously in parallel.[8]

On a more general level, Mandel and Molitor stick to three models of processing – single code, dual code, and mixed processing(Figure 2) with three levels of cognitive depth: interface (or surface), cognitive I, and cognitive II. They argue for a mixed model in which language and visual processing are differentiated, but are ultimately integrated at the deepest and most implicit level.[9] The mixed model is persuasive, both in the light of experimental psychology, and as it pertains to the complementary roles of linguistic and sensory functions.

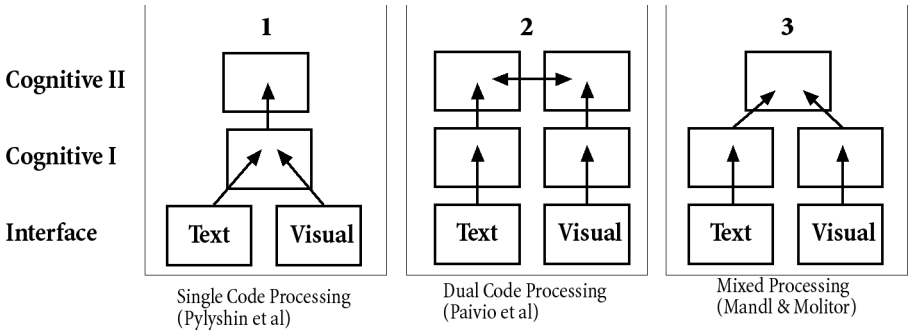


Figure 3: Three Models of Language and Visual Processing (Mandl & Molitor)

The complementarity of symbolic and sensory modes is particularly relevant to experiential cognition: recognition and knowing. Recognition is not merely the identification of a thing under a certain category. It is a holistic apprehension or "grasp" of the thing. If I recognize my mother on the street, that recognition is experiential, and she appears to me spontaneously, as her whole self, freighted with all that I know about her. Knowing is not veridical – a matter of truth – nor a matter of fallible belief, nor is it a matter of inference, but a sense of cognitive resolution: i.e., that I have made sense of what I am experiencing and that I know what I know.

Studies have been made of brain damaged patients who are deprived of recognition and knowing such as afflictees of "Capgras delusion." These persons are able to correctly identify persons they know by inference, but they have no *feelings* of recognition. Without experiential markers, they sometimes come to believe that each re-appearance of a loved one is actually the appearance of a new replicant or impostor.[10] We might say that they "know", but they cannot know that they know. Without phenomenological knowing, knowledge is bereft. The delusion is a psychological reaction to their phenomenological deprivation.

Capgras delusion reminds us of the interdependence of symbolic and sensory domains. Capgras' sufferers are like readers: they have verbal descriptions but no sensory ones. Brain deficits affecting recognition also inhibit recognition of gestalts such as the whole of someone, for example, the cognitive integration of the nose one sees at this instant, together with the eyes one saw an instant ago and the hair

one will see as the parts of a face, that face belongs to a friend, the friend who owes one money, etc. Without the sense of gestalt, we are unable to link experiences into larger units and are often unable to remember them.

The domain of sensory experience is distinct from the domain of language. It complements language and it is often critical to the sense of knowing that enables us to have faith in the world and function in it. The current cognitive and neural models of knowing outmode traditional symbolic notions by demonstrating the relevance of experiential domains that traditional models disregard.

The distinct and complementary roles of sensory and symbolic modes are critical to communication design, which integrates visualization with non-linear forms of "structured writing" into diagrammatic communications. Particularly in multimedia, designers construct both symbolic and sensory aspects of communication, not by shaping existing materials but by constructing them.

Semiotics and multimedia

Multimedia can be an important emerging field for semiotic studies because within multimedia, sensory worlds can be as malleable and as arbitrarily structured as language. Digital technology results in novel communicative forms and it supports the construction of realistic simulations. Lacking an understanding of human cognitive/semiotic function leads to mistaking simulation for metaphor, but the virtual world demonstrates that the two are not the same. The function of sensory design is to construe of the events on screen in terms of certain specific gestalts or cognitive models.

Multimedia design needs its own level of semiotic competence to achieve communicative goals. Such competence must be based on cogent theoretical models which can also be subjected to empirical study: it must be possible to determine unequivocal, operational, empirical expressions which can be measured based on the physical manipulations of temporal and spatial organization that designers use.

This paper operationalizes semiosis in terms of two broad variables:

1. **Cognitive organization**: differentiation of the flow experience into discrete entities by the integration and segregation of elements.
2. **Long term memory**: the stable retention of experience as recollection or recognition over a period of minutes.

It considers the physical aspects of communicative presentations in terms of two variables:

1. **Semantic relations**: the logical connections between elements that support integration and segregation.
2. **Temporal relations**: relative timings and temporal proximities of elements which support perceptual association.

The translation from content to process rests on established findings in psychology indicating that memory is a semiotic expression of experience: not merely a recording of sensations but a schematic representation of experience as cognitively processed and interpreted. First, we do not remember things that do not make sense or do not have have significance to us. Second, we remember things "as": i.e. in the semiotic forms of our understandings. Large scale recollections and recognitions can be decomposed into smaller elements. We remember them selectively, concentrating on the most important ones and forgetting the details that are merely incidental to an interpretation, even when they are in themselves quite vivid.

This method builds a bridge between semiosis and established empirical studies in psychology. It makes it possible to hypothesize and test relationships between cognitive processes with known indicators, and meaning content. It can provide empirical validations of conceptual claims made by semiotics.

Experimental studies of semiosis

Let us focus on portions of two experiments devised to gain access to cognitive reception of cross-mode communication. The first experiment manipulated the semantic relations between video and words to study integration, while the second manipulated relative timings. These were experiments in which subjects were seated at computers and shown a series of movies.

Experiment 1: semantic relations between Video and spoken Words

In experiment 1, each movie was eight to twelve seconds long with a single event on video and a spoken text with a single statement or proposition (Figure 4). There was no one-to-one correspondence between video and words as there would be if, for instance, if there were a video of someone speaking with a synchronized audio of the spoken words. Video and words were independent, perhaps like news footage, let us say of a sailboat cutting through ocean waves, with a voiceover giving the standings of a sailboat race. The relations between the modes varied according to whether the video and words explicitly presented common subject matter, or concepts, if they implicitly presented common concepts, or if there were no credible common concepts or subject matter presented. Insofar as possible, movies were designed not to need specialized knowledge in order to be understood.

A: He pushes me around and he has threatened to throw me out of the sixth floor window of my apartment window twice.
B: Why do you put up with it? I don't understand.
A: Because he has my heart?

Video: gathering, wrapping, and tying letters together with string.

Spoken: two persons discussing an abusive relationship.

Figure 4: Ten Second Movie

Semiosis was operationalized as the integration of video and words into a single gestalt. Processing, or cognitive effort was measured by latency: the length of time required to either make the integration or decide that it was not possible to do so. Thus, at the conclusion of each movie, subjects were asked whether the video and words made sense together (yes or no): that is to say, if subjects could integrate them into a gestalt. Then, they were asked how confident they were of the last response. The computerized method provided a comprehensive record of all behavior including responses and response times for each movie.

From the data, scores were constructed for each movie. A movie's integration score could range from 0% to 100%. Its confidence score could range from 1 if all responses reported low confidence to 3 if all responses reported high confidence. In addition to the responses all the latencies were recorded so latency indices were made for each movie.

Figure 5 shows the frequency distributions of scores. The mean score for integration of movies was 44%, which means that on the whole movies were integrated 44% of the time. On average, it took almost 2 seconds to respond to the integration question, about 1 second of which was keying and reaction time. There was a range of confidence scores. The mean score for confidence was about 2.4, indicating that most responses were in the moderate to high confidence range. The confidence responses averaged near a second, so they were almost instantaneous, indicating that confidence was not a judgment but a feling that could be quickly reported.

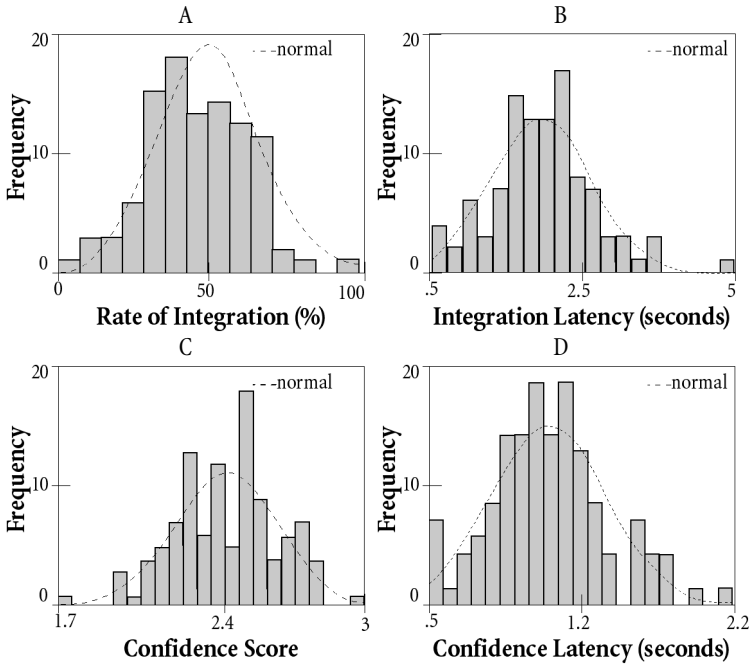


Figure 5: Frequencies for Integration, Confidence, and Latencies

Integration latency showed a significant U-shaped relationship to integration score (Figure 6). It indicated that the movies that were most often either integrated or segregated were processed most quickly (Figure 6). Those with scores near 50% took substantially longer to process, indicating that they were more difficult and required more thinking.

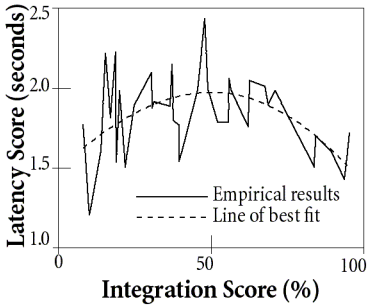


Figure 6: Integration and Integration Latency

Movies with integration scores near 50% were movies on which subjects were split as to whether they could be integrated. In itself, this could be a matter of cultural or individual differences in interpretation, but other measures indicate that individual interpretations were not so idiosyncratic. The relationship between integration score and latency in Figure 6 indicates that behind the apparent differences in interpretation there was a general difficulty in interpretation. Some people reported that the movies integrated while others reported that they did not, but both groups found the movies difficult and time consuming to process.

The movies that were difficult to process were also experienced as ambiguous; subjects felt unsure of their judgments about these movies. There was an even stronger relationship between the integration score of a movie and the mean reported level of confidence (Figure 7). Subjects were most confident of their judgment with movies scoring high and low on rates of integration. Their confidence dropped as the

integration scores approached 50%. The variation in confidence was between 2.8 and 2.0. The R.sq. or variance explained was .616, i.e., 62% the significance was at .000.

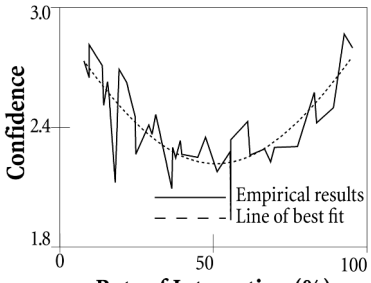


Figure 7: Integration and Confidence

Finally, background information was collected including age, gender and educational attainment. There were some differences between groups: greater tendencies to integrate, slightly different mean reported confidence levels, etc. but the relations such as those in Figure 5, 6, and 7 were highly consistent.

First Experiment: Conclusions

The first experiment makes the case for the importance of semiotic process as distinct from specific codes.

1. **Research**: Cognitive processes are measurable and researchable.
2. **Meaning and Process**: Inferences about meaning can be drawn from cognitive processes. We do not have to rely on self-reports which are difficult to assess. We can use indirect measures. We can also make use of self-reports by linking them to indirect measures.
3. **Species-wide processes**: Those cognitive processes are widely shared across populations. Despite differences in age, sex, and education as well as individual experience, subjects had demonstrably similar reactions to the movies presented indicating that they processed them in the same way and had substantially similar judgments about them.

Second Experiment

The cognitive challenge presented in the second experiment was different from the one presented in the first experiment. In the first experiment, the cognitive challenge studied was semantic: could the video and the text make sense together. The second experiment was also concerned with a sensory challenge – a temporal disturbance – which it used to gain access to the role of cognitive processes in semiosis. While in experiment 1, movies were compared, experiment 2 focused on the effects of temporal disturbances on semiosis and memory.

The second experiment used 20 of the movies which were used in experiment one. In experiment two, however, the temporal relations between video and spoken words were altered yielding nine Delay States 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 (Figure 8). The order of movies and delays were randomized.

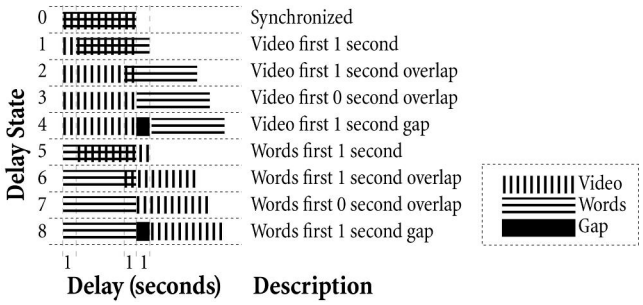


Figure 8: Delay States

Second Experiment, Part 1

As in the first experiment, immediately after each movie was shown, subjects were asked if they could integrate video and words (if they made sense together), and to report their confidence in their judgment (low, medium, or high). Also, as in experiment 1, latencies were measured.

The Integration and Confidence results of experiment 2 showed the inhibiting effect of Delay State on Integration (Figure 9). Integration was highest in the synchronous 0 Delay State, with a score of 52%. It dropped to as low as 35% for Delay States 2 and 3. It dropped significantly with only a 1 second delay in either video (Delay State 1 Integration = 43%), or words (Delay State 5 Integration = 42%).

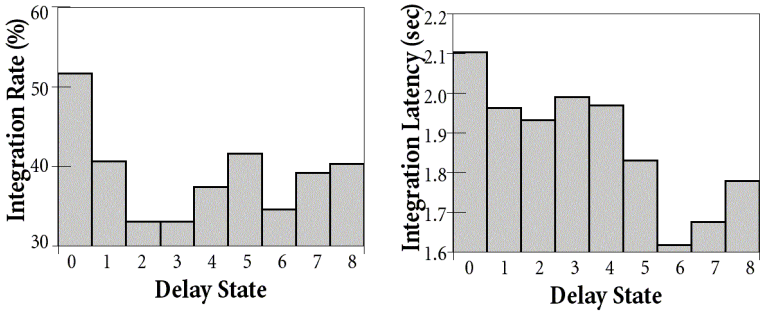


Figure 9: Effect of Delay State on Integration, Integration Latency

To clarify measurements, Delay State was recomputed into two new variables. The variable Delay indicated the amount of delay regardless of mode precedence, while the variable Precedence concerned only which mode had temporal precedence (Table 1).

Table 1: New Variables Derived from Delay State

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

Analyses of the relations of Delay and Precedence with Integration and Integration Latency indicated that delay, not mode precedence, inhibits Integration (Figure 10A,B). Specifically, Figure 10B shows that integration dropped from the synchronized state to either of the delayed states. There was little if any difference in Integration rates between presentations where video was first and those where words were first.

Since there was no one-to-one correspondence between videos and words, a delay of one mode merely altered already arbitrary adjacencies of words and video. The perceived onset of an event can serve as a cue

for cognitive processing. It appears that subjects were attempting to integrate modes based on perceived onset; their semiotic processes were constructing the phenomena they interpreted according to cues. The temporal "misalignment" of modes was perceived as such because it violated the expectation that things that belong together start together. As a result, non-synchronous onset interfered with semiosis. Subjects were trying to realign video and words using sensory or working memory. The lesser effect of a 1 second delay was consistent with compromised cognitive function as delays approach the limits of perceptual memory (Figure 11A).

Delay inhibited Integration and reduced Integration Latency. Precedence of words had no independent effect on Integration, but it reduced integration latency substantially. Unlike integration which is sensitive to Delay but not mode Precedence, Integration Latency sensitive to Precedence much more than to Delay (Figure 11C,D). Latency drops significantly for Delays: i.e., from about 2.1 seconds to about 1.9 seconds (Figure 11C). But, as figure 11D shows, most of that drop is the result of shorter latencies where words are presented first. The difference in integration between synchronized presentation and video first presentation was .1 seconds, while the difference between synchronized presentation and words first presentation was almost .4 seconds.

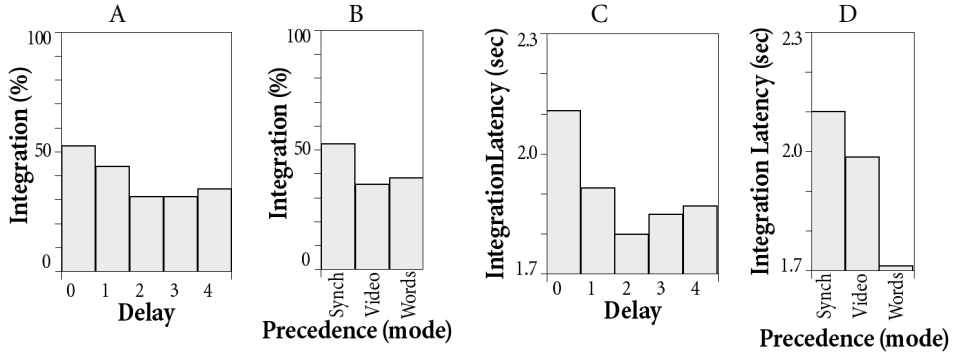


Figure 10: Effects of Delay and Mode Precedence on Integration & Integration Latency

The effect of Precedence on Integration Latency adds another aspect which supports dual code or mixed models of processing (figure 3). Unlike images which simply are, language makes attributions. It offers interpretations so it can directly addresses cognitive needs on the verbal level. Language was likely used to form initial interpretations that satisfied semiosis of the word portion of the presentation, but the ready decodability of language did not materially effect semiosis of mixed mode communications. Words cannot simply be projected onto videos. Both modes must be decoded before they can be integrated.

Semiosis and Memory

In the second part of experiment 2, subjects were tested on their memory via recognition. The strategy was to re-present each of the movies, presenting one of its two modes – either the video or the spoken words – while presenting the other mode from four movies including the correct match (compare Figure 11 and Figure 4). Subjects were asked to correctly match video and words that belong together in one movie as it was playing. In this way, either video or spoken words could serve as a cue for the recollection for the other, and it might be possible to detect which movies were remembered.

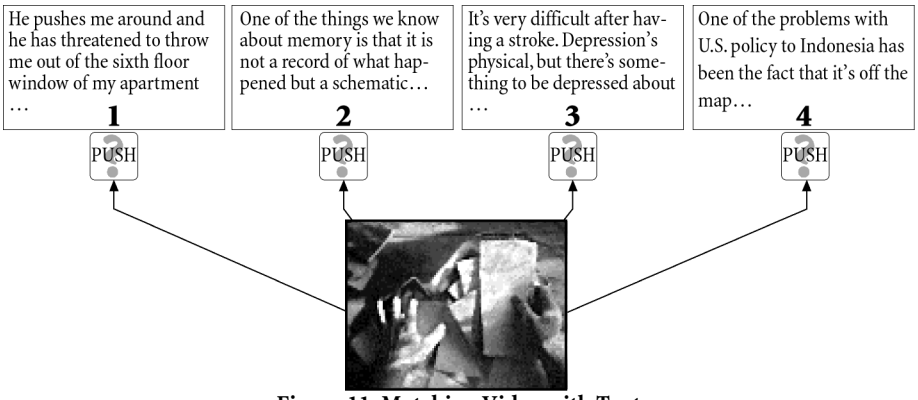


Figure 11: Matching Video with Text

Results for Experiment 2, Part 2

The overall rate of correct identification (Memory) was high: 86% of movies were correctly identified. The overall Memory Latency, i.e. the time it took to match video and words was 8.1 seconds, reflecting the difficult job of matching video and words which involved memory and discrimination between memories while presentations were being shown. The mean confidence was 2.55, indicating that subjects were moderately to very confident of their recollection. Given the high level of correct answers, most of the calls were probably easy.

The major single finding with respect to memory was that the movies that subjects had integrated when they first saw them were substantially better remembered than movies that they had not integrated (Figure 13). Only 7% of integrated movies were not remembered while 13% of not integrated movies were not remembered. For integrated movies, the variable Delay (regardless of which mode has precedence) had no significant relationship to memory, but not for Not Integrated movies Delay generally improved memory markedly (Figure 13).

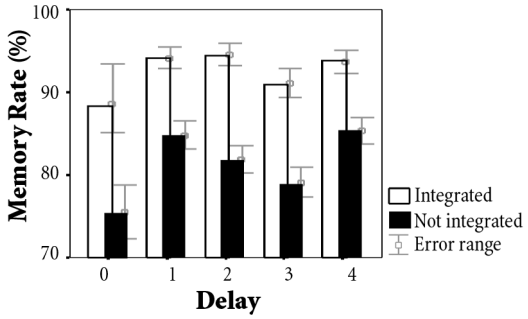


Figure 12: Delay & Memory for Integrated and Not Integrated Movies

This finding points toward a second factor beyond semiotic integration affecting memory: i.e., cognitive work itself. Research on "cognitive interference", challenges like the one presented by temporal shifts, indicates that such interference may inhibit initial learning, like integration, but may also actually "facilitate" longer cognitive effects like memory.[11] Interference and facilitation effects are beyond the scope of this paper.

Review Presentation Variables

The last set of factors to be discussed are the cues for memory recognition: Video or Words. The major question here is whether movies are recognized according to their video or their words. Differences between modes in the potencies of their cues could indicate the relative cognitive importance of those modes with respect to memory which might serve as a guide for design.

The memory score was 91% for movies where words cued video and 83% where video cued words. Thus, it appeared that words served as a better memory cue for video than video for words, but that result is confounded by the effect of Review Latency on Memory, which show that Memory and Review Latency are strongly related (Figure 14).

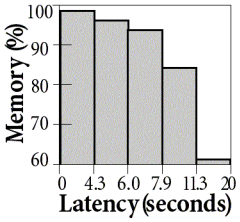


Figure 13: Memory and Memory Latency

It also took longer to process video cues than word cues. Figure 15 indicates that at the shortest latencies, 76% of the cues used words and 24% used video, while at the longest latencies, 73% of the cues used video while 27% used words. This is consistent with earlier findings that Integration latency was much shorter where words were presented first than when video was presented first (Figure 10D).

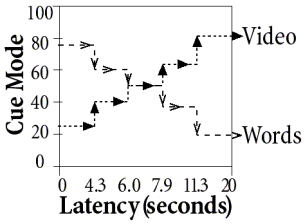


Figure 14: Cue Modes and Review Latency

Once the effects of latency were removed, memory rates for Video or Words as cues were not statistically different. Figure 4.8 shows a consistent relationship between review latency and rate of memory for both video and word cues (Figure 15). Regardless of whether video or words were used as cues, the rate of memory drops rapidly once the latency is above 7 seconds.

This finding indicates that it is not the mode of recognition but the speed of recognition that counts. This experiment was not designed to study speed of recognition by either mode. For example, it used videos rather than still images, which may be more effective.

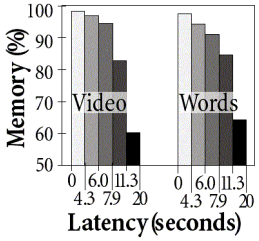


Figure 15: Review Latency and Memory with Video or Words as Memory Cues

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. Delay inhibited Memory largely by inhibiting Integration. But, at the same time, among those movies that were Not Integrated, Delay by itself improved

Memory, probably by increasing cognitive work. The lowest memory scores were for movies that were not integrated and had no Delay. These results are consistent with a theory of facilitation by interference.

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.

Conclusion

This paper proposed a semiotic/cognitive processing model of multimedia communication in order to bridge the conceptual gap between received meaning and the physical configuration of multimedia communications. The goal of this model was to make a path by which meaning can be operationalized, and tested against physical variables. It accomplished the goal by relating meaning to cognitive processes with measurable indicators. The experimental studies and results presented are early and rudimentary.

The experimental design can be refined and extended in many ways.

1. **Refinement of variables**: 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.
2. **New Variables**: 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.
3. **Sequence Testing**: 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. **Human-Computer Interaction**: Methods could be extended to the domain of human-computer interaction and thus to the construction of human-computer activities and their design.
5. **In situ testing**: 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 predictions 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 approach and the research presented in this paper 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.

1. **Findings:** It generates findings in the domain of communication design: practical advice for communication designers. Some findings may be surprising, such as the facilitating effects of interference.
2. **Modeling:** It presents a theoretical model of communications that is testable: it can be used to make hypotheses that can be affirmed or refuted.
3. **Empirical methods:** 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.

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 semiotic approaches to interpretation and replace them with a positivist model. It grounds those approaches by demonstrating their reality, and by examining and applying them.

This approach demonstrates the empirical research possibilities in semiotics and takes a step toward enabling communication design to become a theoretically informed, research-based enterprise that can specify and design communicative outcomes and assess performance.

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