

VISUAL DISPLAYS IN COMMUNICATIONS:  
A REVIEW OF EFFECTS ON HUMAN PERFORMANCE AND PREFERENCE

*Harry E. Blanchard, Joel S. Angiolillo*

AT&T Bell Laboratories, Holmdel, NJ

Abstract: Recently, the renewal of interest in video-telephones has been matched by a renewal of research in media effects in video and multimedia communications. Do people want to see the face behind the voice? Does it help if they do? Studies by psychologists and human factors researchers reveal that information exchange tasks do not show a performance advantage for adding a visual channel, but interpersonal tasks often do. In both types of tasks, however, people show a strong preference for having a video channel.

### THE LURE OF VIDEO COMMUNICATIONS

On May 24th, 1844 Samuel Morse sent the first telegraph message, "What hath God wrought." Soon after, he began working on his next invention, a way to transmit pictures over telegraph lines. Alexander Graham Bell's original interest, as a teacher of elocution, was to help deaf speakers "picture" their speech. Thomas Edison tinkered with Bell's telephone, trying to make the receiving device draw an image instead of driving a speaker. The idea of transmitting pictures was the siren call for these and many other great inventors. The 60's and 70's brought us the Picturephone, an amazing feat of technology for the time, but the service could never sell, and its failure is now part of our folk culture.

Since then, advancements in video compression and other technologies have made it economical to deliver two-way visual communications to the home and office. Videoconferencing is a profitable business, and widespread personal video communication may again be on the horizon, perhaps in the form of videotelephones, but certainly in the form of a multimedia computer workstation with digital video communications.

Now that we are finally masters of the technology, are we ready to face the difficult question: *Who wants it?* Since the first telephone call in 1876, we have learned how to become comfortable with voice-only communications. It is an indispensable tool in the office and a necessity in the home. It works, it is easy to use, and it gets the job done. On the whole, we seem quite satisfied with this ubiquitous and invisible service. Is there a desire to add sight to sound? What will it add to our personal communications?

Of the failure of Picturephone, Noll [17] writes that any future attempt will also be doomed unless we understand human communication and the types of communication for

which there will be a use for video. Ironically, the attempts at video-telephony in the 60's and 70's generated an explosion of psychological research on the value of video in personal communications. Now, interest in multimedia is generating new research on the usefulness of video in face-to-face and group-to-group interactions. What does the research say and does it provide any clues for the success of video telecommunications?

### RESEARCH ON MEDIA EFFECTS IN COMMUNICATIONS

A rich research history of media effects has clearly shown that non-verbal signals facilitate turn taking, discourse planning, and the expression of emotions, feedback and general attention.. For a representative sample see [1, 2, 3, 4, 8, 12, 14, 15]. We will operationally define non-verbal communication as that information that can not be carried directly by an "audio-only" channel, but can be delivered by a visual communications channel.

To take a single example, consider the eyes. When we are in a contemplative or reflective mode we look up. When we are analyzing an argument we look down. And, of course, when we are tired, we close our eyes. When a speaker is ready to relinquish the floor, he or she will frequently directly gaze at the listener. If the listener is ready to take the floor, he or she will momentarily look away. Research has shown that we are even unconsciously aware of, and react to, the size of our speaking partner's pupils [15]. We are scarcely aware of this complex dance of the eyes and if we focus our attention on it, we become immediately entangled in our own self-consciousness.

For our purposes the interesting question is not how non-verbal cues, like those offered by the eyes, support communication, but rather how we manage to do so well without a visual channel. After all, we have never had the luxury of a visual channel in our long distance communication. The letter is a text-only device and the telephone is a voice-only device. What have we been missing? What will video add to our communications?

Psychologists have had a remarkably straight forward approach to answering these questions: Add a visual channel to a conversation and see what happens. The procedure used in field and laboratory studies can be generalized as follows: Two subjects (or groups of subjects), in different locations, are asked to perform a task that requires both cooperation and communication. For

example, one has a telephone book and the other a desire to find a particular restaurant. The type of communication channel between the two is varied, for example, voice-only or voice plus vision. The experimenter then collects measures of performance and user satisfaction.

### User Performance

One of most basic measures of communicative success is the time it takes to exchange information. Ochsman and Chapanis [18] asked pairs of subjects, in separate rooms, to perform three different tasks: scheduling a class, finding the problem in an ignition system, and finding a particular part in a bin of similar looking parts. The tasks were designed so that both subjects had to work together to solve them. Subjects were placed in one of ten conditions, which included: typewriting only (simulating an email connection), handwriting only, handwriting and typewriting, typewriting and video, handwriting and video, voice only (simulating a telephone), voice and typewriting, voice and handwriting, voice and video (simulating a closed circuit TV), and all five channels. Because the subjects had enough time to complete the tasks without error, the only measure of performance was time to complete the given task. Their extensive analysis of the results shows that a voice channel is essential for successful performance in an information exchange task, but a visual channel did not add significantly to the audio channel.

In a series of unpublished experiments performed by Short at University College in London between 1971 and 1973 (reported in [20] and [21]), it was observed that the type of communication media did not dramatically affect subject's performance when the task involved trading information and negotiating, except that, contrary to most people's intuition, significantly *more* opinions were reversed or modified in the audio condition than the face-to-face condition, with video in-between the two.

Gale [10, 11] had groups of subjects perform three different information exchange tasks: deciding on the best alternative among a set of possibilities, deciding on the quality of a good product manager, and setting up a meeting. Subjects, in small groups, used one of three different media: Data sharing (computers linked so that what one person typed on his or her screen shows up on each person's screen in the work group), data sharing plus audio, and data sharing plus audio and video. Like Ochsman and Chapanis, Gale found that the media choice did not effect the time to complete the different tasks.

These representative studies provide strong evidence that when (non-visual) information must be transmitted or negotiated between two or more people, the words we

speak are all that we need. It appears that the telephone is a pretty successful device for such cooperative work.

### User Perceptions

The typical study involving the exchange of information is looking for *performance* differences. Some studies have also asked subjects which media they *prefer*. Generally, they prefer the more "information-rich" channels (channels with vision) even though the addition of vision does not seem to improve performance. One reason might be that channels with vision are rated as higher in *social presence*, that is, subjects feel that they know their partners better at the end of the study. Gale [11] reports another interesting finding. Subjects *thought* that the voice plus vision channel would save them time in real life, even though his laboratory study did not show that it would.

Tang and Isaacs [23] also found that user perceptions don't always match user performance. In their study of a real life work team, desk-top video was added to the team's repertoire of communication tools midway in the project. Participants *reported* that, with the addition of video, they needed to meet by phone or email less often than before, while the actual data showed little or no difference.

Young in a series of unpublished studies in 1974 and 1975 (see [21]) found no statistically significant media effects. For example, subjects are no better in determining whether a partner is lying in voice-plus-vision as opposed to voice-only conditions, although subjects in voice-plus-vision conditions tended to be more confident in their judgments. Even though subjects are not actually any more accurate in determining what another's feelings, they *think* they are and they think their partners are more accurate in deciphering their own feelings. We like to think we are perceptive and convincing even if we aren't [25].

### Interpersonal Tasks

Interpersonal tasks look at the role non-verbal communication plays in communicating not what we say or hear, but what we *think about* what we are saying or hearing. Although the results are often task specific, the general finding from a number of studies ([7], [16], [21] and [24]) is that when two people can see each other they can more successfully come to agreement on a solution to a problem or a plan of action. This seems to especially true when one or both of the subjects are negotiating from a position they believe in. One reason for this may be the finding that with a voice plus vision channel subjects are better able to determine their partner's position on an issue than they were in an voice-only condition.

Williams [25] used an interesting variation on the interpersonal task. He had four-person groups, two on each

end of the communications channel, participate in a brainstorming session. (The topic was “Improving travel in Great Britain”.) Fifteen two-person groups were connected by an audio-only link, and fifteen by an audio plus video link. The choice of media did not effect the number or quality of ideas generated, but Williams recorded a surprising finding. With audio-only links subjects were much more likely to disagree with a person at the opposite end of the call as opposed to the person in the same room. With audio plus video links there was the same chance a subject would disagree with a person in the same room as in the remote room. Audio-only connections seem to encourage an us-versus-them mentality.

Two real-life project teams observed by Tang and Isaacs [23] felt that video contributed to the smooth workings of the teams. The teams liked the video and used it often.

Our own observations support the notion that video changes the dynamics of meetings and makes people feel better about their interactions. Over the course of a year, both authors participated in numerous audio and video conferences with the same team of 20 AT&T employees. The majority of the team was in one location, with a smaller number in a second location. In audio conferences the larger group would tend to dominate the meeting, to the chagrin of the smaller group. Video conferences brought both sides of the meeting together more effectively, in particular, the smaller group reported feeling more a part of the team. This may in part be due to a secondary effect of video. Because one is “on air” the entire meeting, one tends to focus on the agenda at hand, instead of hiding behind the anonymity that an audio-only connection (especially with a Mute button) affords, an anonymity that allows one to read mail, write letters, and carry on side conversations.

### Video Measures

One significant problem in interpreting experiments on the addition of a video channel is that not all video is created equal. One can feel confident that all audio channels will be pretty much the same (3.3 kHz), face-to-face is face-to-face, and email is asynchronous text. But not so with video. The studies range from “imagine we provided you with video...” to 30 frames per second closed-circuit TV to low quality compressed video. In particular, studies using compressed video can vary greatly in the quality of the video, as measure by the screen size, the screen resolution, the frame rate, and the delay. The introduction of audio delay in studies of video communication is particularly worrisome. In the Tang and Isaacs study [23] the frame rate was only 5 frames per second with close to a half second one-way delay in the transmission. This delay was so bothersome, that the participants would often turn off the audio, place a separate voice call with no delay, and in the

process sacrifice lip synchronization. If users do not find the video useful, or if performance measures do not show a video advantage, is there an intrinsic lack of functionality with the video, or are subjects responding to the poor video quality?

## CONCLUSIONS

In summary, information exchange Tasks usually do not show a *performance* advantage for adding vision to a voice channel. As communicators we successfully accommodate to the lack of non-verbal communication we send and receive. On the other hand, interpersonal tasks often show an advantage for video. The advantage of the visual channel appears to be that it allows people to pick up non-verbal messages and it encourages attentiveness and commitment to the task.

Finally, studies repeatedly show that subjects simply *like* video better than audio conferencing [20]. The term that has been given to this phenomenon is *social presence*. Media-rich environments have more social presence and are more often selected by subjects. Subjects feel like they know their partner better with video and this is apparently reinforcing. (See [5] for a careful analysis of semantic differential scales for face-to-face, video, and audio.) At the same time, video conferencing is more often like audio conferencing than it is like face-to-face meetings.

A new perspective is developing on video communication in recent years. This is the use of video to support other communication in addition to person-to-person contacts and formal meetings. The Media Space project at Xerox PARC [19] and the Crusier system at Bellcore [9], for example, both experimented with using video to support *informal* and spontaneous communication. Video appears to encourage spontaneous interaction in a continuously available cooperative multimedia computing environment. Thus, another key to understanding the usefulness of video may be to break out of the mindset of video as simply an addition to a telephone conversation or conference call.

## PERSPECTIVES FOR FUTURE INVESTIGATION

The question is not whether we will all replace our voice phones with video phones, but when and how will we choose to use visual telecommunications. The research of the last three decades points us to several areas for further study.

### Redundancy

Claude Shannon [22] in formulating his theory of information, realized that a communication system's tolerance of transmission errors is directly proportional to

the signaling redundancy. Is it possible that in optimal conditions, the voice channel can make up for the lack of a visual channel, but in non-optimal conditions the visual channel provides useful redundancy?

### Non-Communicative Role of Speech

John Lyons [13] writes that “many of the important functions of language are not in fact communicative.” The tests described above have looked at communicative tasks. Is it possible that we are missing other important non-communicative functions of language, for example, providing emotional closeness?

### Task-Effects

Adding sight to sound will not necessarily improve communication: it depends on the purpose of the communication. Christie [6] writes “A medium which is low on social presence, e.g. the telephone, is not very suitable for person-oriented tasks, e.g. recruiting a new manager or more generally getting to know someone. On the other hand, the telephone or other medium low on social presence is suitable for task-oriented activities such as a simple exchange of information, placing an order, and so forth.” In addition, investigation of computer-supported cooperative work systems suggests that video may play a special facilitating role in informal communications. We need to continue to investigate these task differences to see when (and how) sight will contribute to sound.

### Effects of Video Quality

The current generation of video communications devices relies on video compression technology, which brings along a degradation in image quality and motion reproduction, and delay in video and audio. Thus, an entirely new factor must be considered: what are the performance and preference effects for adding video to a conversation or meeting, when that video is less than television-level quality? What are the effects of signal delays on interpersonal tasks and user preference, e.g. for a delayed video connection versus a non-delay audio one?

## REFERENCES

1. Argyle, M. 1972. “Non-Verbal Communications in Human Social Interaction” in *Non-Verbal Communication*. Ed. R. A. Hinde. Cambridge University Press. 243-269.
2. Argyle, M., M. G. Lalljee, and M. Cook. 1968. “The Effects of Visibility on Interaction in a Dyad.” *Human Relations* **21**: 3-17.
3. Argyle, M., and R. McHenry. 1970. “Do Spectacles Really Affect Judgments of Intelligence?” *British Journal of Social and Clinical Psychology* **10**: 27-9.
4. Birdwhistel, R. L. 1952. *Introduction to Kinesics*. Louisville, Kentucky: Louisville University Press.
5. Champness, B. G. 1973. “Attitudes Toward Person-Person Communications Media,” *Human Factors* **15**: 437-448.
6. Christie, B. 1981. *Face to File Communication: A Psychological Approach to Information Systems*. New York: Wiley.
7. Dorris, J. W., G. C. Gentry, and H. H. Kelley. 1971. *The Effects on Bargaining of Problem Difficulty, Mode of Interaction, and Initial Orientations*. Amherst, MA: University of Massachusetts.
8. Ekman, P. 1969. “Non-Verbal Leakage and Clues to Deception” *Psychiatry* **32**: 88-106.
9. Fish, R. S., R. E. Kraut, R. W. Root, and R. E. Rice. 1993. “Video as a Technology for Informal Communication” *Communications of the ACM* **36**: 48-61.
10. Gale, S. 1990. “Human Aspects of Interactive Multimedia Communication.” *Interacting with Computers* **2**: 175-189.
11. Gale, S. 1991. “Adding Audio and Video to an Office Environment” in *Studies in Computer Supported Cooperative Work*. Ed. J. M. Bowers and S. D. Benford. Amsterdam: Elsevier Science Publishers.
12. Kendon, A. 1972. “Some Relationships Between Body Motion and Speech: An Analysis of an Example” in *Studies in Dyadic Communication*. Ed. A. Siegman and B. Pope. Elmsford, NY: Pergamon.
13. Lyons, J. 1972. “Human Language” in *Non-Verbal Communication*. Ed. R. A. Hinde. Cambridge: Cambridge University Press. 49-85.
14. McNeill, D. 1992. *Hand and Mind*. Chicago: University of Chicago Press.
15. Miller, G. A., ed. 1973. *Communication, Language, and Meaning*. New York: Basic Books.
16. Morley, I. E., and G. M. Stephenson. 1970. “Interpersonal and Interparty Exchange: A Laboratory Simulation of an Industrial Negotiation at the Plant Level” *British Journal of Psychology* **60**: 543-545.
17. Noll, A. M. 1992. “Anatomy of a Failure: Picturephone Revisited.” *Telecommunications Policy* **18**: 307-316.

18. Ochsman, R. B, and A. Chapanis. 1974. "The Effects of 10 Communication Modes on the Behavior of Teams During Co-Operative Problem-Solving." *International Journal of Man-Machine Studies* **6**: 576-619.
19. Olson, M. H., and S. A. Bly. 1991. "The Portland Experience: A Report on a Distributed Research Group." *International Journal of Man-Machine Studies* **34**: 211-228.
20. Pye, R., and E. Williams. 1977. "Teleconferencing: is Video Valuable or is Audio Adequate?" *Telecommunications Policy* (June): 1977.
21. Reid, A. A. 1972. "Comparing Telephone with Face-to-Face Contact" in *The Social Impact of the Telephone*. Ed. Ithiel de Sola Pool. Cambridge, MA: MIT Press. 386-414.
22. Shannon, C. E. 1948. "A Mathematical Theory of Communication." *Bell System Technical Journal* **27**: 379-423, 623-656.
23. Tang, J. C., and E. A. Isaacs. 1992. "Why do Users Like Video? Studies of Multimedia-Supported Collaboration," Mountain View, CA: Sun Microsystems Laboratories, December.
24. Wichman, H. 1970. "Effects of Isolation and Communication on Cooperation in a Two-Person Game." *Journal of Personality and Social Psychology* **16**: 114-120.
25. Williams, E. 1975. "Coalition Formation Over Telecommunications Media." *European Journal of Social Psychology*.