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Interactive Cognition: Exploring the Potential of Electronic Quote/Commenting

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Human cognition is not an island unto itself. As a species, we are not Leibnizian Monads independently engaging in clear, Cartesian thinking. Our minds interact. That's surely why our species has language. And that interactivity probably constrains both what and how we think.

Although Wittgenstein's argument that there could be no "private language" -- because language is based on rule-following and rules are shared social conventions -- is probably overstated and refutable, for present purposes it is valid enough: Language is the main medium of interaction of our species and it is fundamentally interactive, dialogical. It did not evolve to leave us lost in subjective, solipsistic thought. In terms of the time we spend doing it, conversing probably exceeds all other forms of human interaction, including feeding, fighting, playing, mating, and the "grooming" that some have argued it has evolved to replace (Dunbar 1993 http://www.bbsonline.org/documents/a/00/00/05/65/index.html).

The origins of language have been the subject of much speculation (Harnad et al. 1976 http://cogprints.soton.ac.uk/documents/disk0/00/00/08/63/index.html), but perhaps a few things can be said about it with some confidence: Language began hundreds of thousands of years ago, and whether it started as gesture and then moved to speech (Steklis and Harnad 1976 http://cogprints.soton.ac.uk/documents/disk0/00/00/08/66/index.html), or went straight into speech, the kind of adaptation it was was undeniably an interactive one: Speech accordingly has a characteristic real-time dyadic tempo. There is certainly some variation in the rates at which people speak, the optimal speaking rates they understand, their attention spans, their memories, etc., but, to a close enough approximation, the timing parameters of a contemporary TV chat show are probably representative of our species since very near the advent of language.

There are consequences of this: Speak too fast or too slow, and I won't be able to understand you. A subtler consequence (having to do with the memory and attention-span factor) is that if you speak for too *long*, I'll have trouble understanding too, and I'll only be able to respond to what you said near the beginning of your speech, or

near the end, or to some selected portions that caught my attention in the middle. Chances are that the adaptive value of language in the original environment in which it evolved
derived from relatively rapid exchanges of relatively short strings of information, again more like a conversation or a chat show amongst a few interlocutors than a long lecture by one orator to a throng -- that came too, but it came later. Although the adaptive scenarios people have proposed are without exception mere speculations, they are all variants on the idea that the utility of language must have been connected with its use in hunting, tribal defense, tool-making, and/or training others (especially the young) in these or other essential hominid survival skills. With the exception of pedagogy (which was probably a later development), it's hard to imagine these uses of language as consisting of long monologues: Relatively short interactive comment and response were probably the order of the day, performed at about the speeds we perform them today. But even if primal conversations were one-sided rather than interactive, a rate-limiting factor was how fast we could speak and understand, and how big a chunk we could remember long enough for it to have any useful effect
(Miller 1956 http://cogprints.soton.ac.uk/documents/disk0/00/00/07/30/index.html , Cowan 2001 http://www.bbsonline.org/documents/a/00/00/04/46/index.html).

So it is likely that because of real-time constraints on articulatory rate, the speed of thought co-evolved with the speed of speech; their rates converged on roughly the same order of magnitude (though one hopes we thought a bit faster than we spoke) and were in phase. And that's still the way things stand now, *biologically* speaking, for, after the advent of language, the rest of the developments in the linguistic arena were *technological* (and cultural) rather than biological -- feats of "cognitive engineering," if you like: We invented the new medium of writing, so words, and the thoughts they conveyed, could then be transmitted beyond the reach of any individual human's voice, ears or memory. (The oral tradition had done this in part, but imperfectly, and only through the mediation of a vocal internuncio.) Then we invented the medium of printing, so words and thoughts could be transmitted beyond the reach of any individual human's pen or paper (Harnad 1991 http://cogprints.soton.ac.uk/documents/disk0/00/00/15/80/index.html).

Writing and print were not only ingenious ways of preserving and distributing thoughts, but they also freed us from many of the immediate constraints of memory and attention span, because written words could be read and re-read, allowing messages to be longer and more complex than anything one could hope to convey orally. They could also be written and rewritten, allowing messages to be more careful and disciplined than anything the rapid pace of spontaneous conversation could ever generate. But this lapidary property of the written word was purchased at a price: The interactivity of speech was gone, or at least it was slowed down to a pace that hardly seemed worthy of the word "interactive" at all -- considering the speed, commensurate with speech, of which human thought had already proved itself capable in the oral era: So literality did, in a sense, make us more like monads conducting monologues. To be sure, we were writing letters to one another, and replying, sometimes on the same day, but it
was rather like what had formerly been a jig, danced together, turned instead into a sarabande, danced in lugubrious alternation -- or, to pick a more cognitive example, a long-distance chess game in which the players make only one or two moves a day, and spend the rest of the time waiting to learn their opponent's response: There was something profoundly out-of-phase about it, or rather about the thoughts behind it, which in real-time dialogue would have interdigitated instead of
proceeding in fits and starts.

The chess analogy is instructive, because, unlike a conversation, a chess game often involves long periods of motionless thought, and being rushed makes one play less well. Yet the game is interactive, and if it *were* to be played with limitless time between moves, it would no longer be the same game (and would perhaps no longer draw on the same cognitive capacities). Slow-motion tennis would be even more obviously a different game.

These analogies are imperfect, but the point I do want to make is that in written dialogue as well as in slow-motion chess, apart from the extra time one is happy to take in order to reflect more, there is a great deal of dead time too, in which one's thoughts are idling, waiting for the other shoe to drop.

Nor is the limitless reflection time an unmixed blessing in itself: Necessity is the mother of invention. What would become of the spontaneous wit of a brilliant salon conversationalist if each item of repartee could be put on limitless hold for pondering before transmission? Would dancing ability (in an age when dancing was still interactive) or tennis prowess be the same if each move and each shot could be preceded by hours of deliberation?

Again, chess, being cognitive, is the most instructive case: In principle, given infinite time. every possible move could be tried in advance, and hence the optimal one could be picked. But trying every possibility is not usually the way cognition goes, and certainly not what we regard as "creative" cognition: The cognitive "moves" we regard as brilliant are not the ones that are a result of mechanically going through all the possibilities, but the ones that somehow find a pattern latent in all the dreary combinatorics, a pattern that swiftly and directly generates a solution to a problem that looked hard until the pattern was discovered (http://cogprints.soton.ac.uk/documents/disk0/00/00/16/27/index.html).

The human mind occasionally discovers such patterns. It's impossible to quantify this -- to say how often this happens, or how improbable and consequential the patterns really are. Sometimes we discover things through long, noninteractive reflection, to be sure. But, given the evolutionary history and temporal parameters of language and thought, it is probably safe to say that it is in real-time cognitive interactions between minds that the resourcefulness of human cognition is most firmly engaged.

This essay is by no means intended as a polemic for a return to an oral culture, however! The power gained from the discipline of slowing thought down to the pace of writing, and preserving it verbatim, answerable for its validity not merely to the persuasive force of one orator on one occasion, but the endless scrutiny of peers and posterity, was probably almost as revolutionary a technological and cultural advance for human thought as the advent of language itself had been. But let us not forget that in exchange for those virtues of the lapidary medium (writing) we sacrificed some of the virtues of the labile one (speaking), particularly the possibility of minds interacting at the speed of thought. Could one have the best of both worlds?

Not in the medium of speech, which vanishes as it is uttered. Recording it is no help, because what one really needs is playback and editing capacity, for both one's own utterances and one's interlocutor's. And by whatever cognitive engineering means one might secure this -- whether the playback/editing is in the phonological medium or the graphemic one -- the need to do two things rather than one (i.e., not just to listen and speak to one's interlocutor, but to monitor and modify the record of what has been said by both parties) rules out what might might have *seemed* to be the ideal solution, namely, real-time interaction by writing.

It's not just the slow speed of writing that is the problem; even if a speech-recognizer could generate error-free graphemes as fast as we could talk, and even if we could read these as fast as we can hear, this would still leave us back where we were with spontaneous conversation: We would merely have an instant transcript, but no more opportunity for reflection. It is in part for these reasons that -- except for quick, urgent messages -- most people find the real-time Unix "talk" facility so unsatisfying. It's not just the frustration of watching someone else's slow typing, and backspacing to correct typos, or the bottleneck of one's own typing, but that one feels that if this was just a chat, we could just as well have talked by phone, and if careful reading and serious reflection were called for, off-line email would have been better.

So is email just a somewhat accelerated form of ordinary mail (which, as I said, even in the past sometimes had same-day turnaround)? And are we irretrievably severed by the written medium from the interactivity of the real-time dialogue for which our minds are biologically adapted?

I think not. Although fast paperless mail was what email may originally have been intended for, it has turned out to have some unexpected consequences, opening up some revolutionary possibilities. First, let us not under-rate the

speed factor. In principle, for a message of just about any length, it can reach my interlocutor the instant I complete it. Second, it can at the same instant be branched to multiple interlocutors (in principle, to everyone). These two factors, of speed and scale are without precedent, but they are still noninteractive ones, insofar as the speed of thought is concerned. Rhat is not all, however. Instantaneous and flexible text-capturing, quoting and commenting capabilities allow a form of highly focused and selective off-line interaction with the text that *does* engage the real-time speed of thought, and engages it interactively, yet in the lapidary medium, and with precisely the playback/editing facilities that were missing in real-time dialogue (*verba volant, scripta manent*).

Recall the memory and attention-span constraint on the *length* of a particular utterance in oral dialogue: Run on too long, and your interlocutor will lose continuity, forget, and misinterpret. One is tempted to say (to a long-winded interlocutor): Why don't you just write me a letter? Long-winded conversations, if they do not turn into one-sided monologues (which are a fortiori noninteractive), are more likely to be divergent duo-monologues -- each interlocutor in turn launching off from some point in the primacy/recency memory curve for the preceding peroration that they have just endured impatiently, waiting their turn -- rather than convergent dialogues, which require each interlocutor to be relatively brief and to the point (so it can be ensured that it is the *same* point they are both addressing).

Well, in the quote/comment capability that email has made possible, a long-winded passage can be given full attention (if it deserves it); it is preserved verbatim, free of memory constraints, to be re-read as often as one wishes; and, most important of all, it can be selectively edited down to the specific points one decides to address in replying, and the reply can then be focused on those passages, quoting them so as to provide the full requisite context. One's own reply, too, has the benefit of the playback and editing capability, and can be written and rewritten till one feels one has gotten it right. Moreover (and it is for this reason that I have dubbed this form of interaction "skywriting"; Harnad 1990 http://cogprints.soton.ac.uk/documents/disk0/00/00/15/81/index.html), in engaging in this form of real-time cognitive interactivity with electronic text, one can also keep in mind that it is not only one's interlocutor who will see one's quotations and comments, but all the others to whom the message was branched: This is like the benefit of a trial by jury without the real-time pressure and stage fright of oral testimony; or like a public debate conducted in writing; or like a symposium and discussion likewise conducted in writing; but writing in a new key: at electronic speed and scale, and with the powerful playback/editing capability just described. Most important of all, a permanent, public record of the interaction is preserved in the form of a "Hypermail" Archive: http://www.cogsci.soton.ac.uk/~harnad/Hypermail/

I realise that these resources are quite familiar to all of you, but sometimes a thing has to be "made strange," as Schopenhauer termed it, and looked at as if for the first time, if one is to see its true properties and potential, particularly if it is something relatively new that has become a familiar commonplace too quickly, as email has done. The text-capturing quote/comment tools and conventions that have rapidly developed in the past decade were not the work of cognitive engineers, experimenting with and optimising emerging interactive resources. They were simply co-invented out of expediency by emailers. I'm not sure where the "> " convention for setting off quoted passages started, but it quickly becomes unworkable with multiple levels of quoted text, even when supplemented by preceding the ">" with each interlocutors initials. It was probably born on Usenet and carried over to Unix mailers, or vice versa. It is certainly not a successful piece of cognitive engineering, yet it is an absolutely remarkable capability that deserves to be closely analysed and developed, because it is the means by which the best of both worlds -- labile speech and lapidary writing -- can be realised. But before closing with a description of the kinds of studies that we will be doing on text-capturing at Southampton University in the next few years, I would like to motivate them with two two anecdotes from my own experience that I suspect will resonate with experiences many of you have had too.

The first anecdote concerns my own first exposure to "skywriting": In 1980, there had appeared in Behavioral and Brain Sciences (BBS), the journal I edit, an extremely controversial critique of Artificial Intelligence (AI) by the

philosopher John Searle called the "Chinese Room Argument" (http://www.bbsonline.org/documents/a/00/00/04/84/index.html). Most people, including me, thought the Argument was wrong; after umpiring several years of critical commentary on it in BBS, I was writing my own critique of it in the mid '80s when it was drawn to my attention that on "news:comp.ai" -- the Usenet chat group devoted to discussions of AI -- a discussion of Searle's Argument had been going on for several years.

I tuned in to see what had been said, and perhaps add my own critical voice to the throng, but quickly discovered two things: First, the critics were mostly not cognitive scientists but computer programmers and students. Second, all of their Counterarguments to Searle were wrong. Now I myself considered Searle's Argument to be wrong at that time, but before posting my own critique I wanted to dispel the clouds of invalid arguments that were in the air, so I took them on, one by one (though often they were just variants of the same wrong reasoning or assumptions or conclusions), and I consciously did so as if my contributions were formal commentaries in a learned journal (even if the postings I was commenting on had not been that scrupulous), except that I adopted the Usenet quote/comment convention.

The results were quite remarkable. The archive of my own discussion quickly reached booklength. I spent countless hours on the Net every day, taking on all comers, patiently replying to different variants of the same bad arguments a different way each time, so it might not bore but inform the silent majority that I assumed were following all this. (I still have no idea how many were "tuning in"; although Usenet's Arbitron statistics estimate the total readership of each group, one does not know how many of them -- and who -- are following a particular discussion "thread.") And though my behavior no doubt had obsessive-compulsive features, I don't regret the time I spent at it at all: Necessity is indeed the Mother of Invention, and in the course of that Skywriting Tournament, defending Searle against invalid criticism, I came up with some positive ideas of my own, including a hypothesis about what the real problem underlying Searle's critique of AI was (the "Symbol Grounding Problem" -- its name was born as the subject of one of the threads of the Searle discussion, and it has since become one of my more important papers; Harnad 1990 http://cogprints.soton.ac.uk/documents/disk0/00/00/06/15/index.html) as well as a potential solution to the problem (Harnad et al. 1991 http://cogprints.soton.ac.uk/documents/disk0/00/00/15/79/index.html).

It is unlikely that I would have come up with those ideas otherwise. The essential features were the real-time interactivity, the quote/comment capability, and the long series of determined interlocutors. It has since occurred to me that the exercise might have been even more fruitful if my adversaries had not just been students and programmers, but the best thinkers in the field -- and that eventually impelled me to start a refereed electronic journal (Psycoloquy http://www.cogsci.soton.ac.uk/psycoloquy/) and to become a polemicist for the online self-archiving of the refereed research literature (http://www.cogsci.soton.ac.uk/~harnad/Tp/resolution.htm), but that is another story. What's relevant here is that even with that less than optimal demography, the interaction proved to be such a powerful idea-generator for me. Nor was there any doubt in my mind that the quote/comment feature was at the hear of it. Which brings me to my second anecdote, mercifully shorter than the first:

It was around that time that I noticed that I -- a compulsive reprint/preprint collector since the 70's -- completely lost my taste for on-paper texts: If someone sent me a paper reprint, I would email them to ask if they didn't perchance have an on-line version. Why? Not because I find the current generation of VDU's any more appetising to look at than you do, but because of the quote/comment (Q/C) capability. I had become addicted to it *as a way of interacting with text*, irrespective of whether it came from a "live" posting or a "dead" text (even by a dead author!): Either way Q/C made it alive for me. The technique was the same. Read it on-screen, save a back-up full copy, then start selectively deleting the irrelevant or uncontroversial passages, leaving only the skeleton of what I wanted to address in my "reply". But who was this reply for? Well, in some case I could think of it as being for the author, but usually that was not enough for inspiration. So I set up some discussion groups involving multiple minds, all interested in the topic under discussion. (A population of Skyreaders is essential to the inspirational power of Skywriting.) And as with the symbol grounding discussion, often -- not always, but often enough -- the

interaction would generate the germ of my next published article. And meanwhile Hypermail Archives (http://www.cogsci.soton.ac.uk/~harnad/Hypermail/) could serve as the permanent SkyDocument of record (see also Hayes et al. http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad92.virtualmind.html Flach & Powers 1993 http://cwis.kub.nl/~fdl/research/ti/docs/think/2-1/index.stm and http://www.cogsci.soton.ac.uk/cgi/psyc/newpsy?12.034 as well as Okerson & O'Donnell 1995 http://www.arl.org/scomm/subversive/toc.html) to see how Skywriting can sometimes spawn terrestrial incarnations too.

I don't want to overstate the case, since it is based on anecdotal experience -- though I'll bet that many of my readers have had similar experiences, of ideas being generated through the electronic interaction with text, so let me close by describing a series of studies that will try to examine systematically the effects of the unique form of cognitive interaction that electronic skywriting -- and the quote/comment feature in particular -- has made possible:

Electronic networks have made two new forms of interactivity possible: One is between people and people (electronic mail, individual and multiple, Harnad 1991; Lea 1992; Sproull & Kiesler 1991) and the other is between people and texts (electronic texts and hypertexts, Ginsparg 1994, Romiszowski 1990; McKnight et al. 1991, 1993). These new interactive resources are already becoming widespread, but some of the unprecedented capabilities they have spawned (Harnad 1990, 1992; Berge & Collins 1994) now need to be systematically analysed and optimised from a cognitive engineering standpoint (Hall 1994, Hutchings et al.1993; Benabas & Todd 1993; Diederich et al. 1992) so the findings can be applied to the acquisition, generation, and sharing of information in research, education and commerce. What needs to be analysed experimentally is text-capturing, which I consider to be one of the most powerful of these new interactive capabilities, in order to evaluate and develop through cognitive engineering its potential contribution to knowledge acquisition and generation. Here are some of the kinds of studies that need to be done; some are underway at the Cognitive Sciences Centre at Southampton University

One-to-one Electronic Mail (Email) Interactions.

The power and value of email in the transmission of messages between people is well known (D'Sousa 1992; Golden et al. 1992; Sproull & Kiesler 1991; Carley & Wendt 1991). What seems to have gone unnoticed is a subtle but potentially revolutionary change that has evolved in the *form* of that communication. In an electronic message, it is possible to capture the text of the message to which one is responding and to re-quote it by responding in the form of point for point quotation and commentary. In speech, this is clearly impossible, as one forgets what one has heard too quickly to be able to requote it verbatim and then comment on it. As a consequence, verbal conversations may wander off the topic and both parties may feel that they have not been fully understood or accurately represented. In writing on paper, on the other hand, it takes much too long to retype what one's interlocutor has said, so again communication may wander from the point and discussion can be to varying degrees at cross purposes. Adding to this divergent tendency in written interaction is the long turn-around time between
written messages.

Email makes written interactions much more focused and convergent, both by (1) scaling up their speed to something that is potentially almost as fast as an oral conversation, yet without forfeiting the discipline and permanence of writing (Harnad 1990; Bolter 1991; Horowitz & Samuels 1987), and (2) by making it possible, through quotation and requotation, for the interaction to converge ever more intensively on what is actually being said, rather than allowing the interlocutors to diverge in their own respective directions (Sein & Robey 1991).

This novel quote/comment mode of interaction (henceforth Q/C) has not yet been objectively studied or systematically compared with standard modes of communication, oral and written, yet there are indications that it has opened the door to remarkable new possibilities, both in the acquisition of knowledge and in the development of ideas (Harnad 1991; Heseltine 1994; Holden et al. 1993).

The first objective of our research on interactive cognition is accordingly to do a systematic comparison between electronic communication with and without the Q/C capability.

Study 1:

Participants will be one hundred and forty undergraduate students, but Study 1 will be conducted outside the context of their normal studies and their major disciplines. Eighty students will be given group-based instruction by a professional instructor on a self-contained piece of nontechnical subject matter. Twenty of them (all group assignment will be random) will then take a brief essay and multiple choice examination to test for mastery of the subject matter.

The other sixty will be assigned one of sixty (noninstructed) student "tutees" to whom each must teach the subject matter. Twenty will teach it orally, within a specified period of time (to be chosen on the basis of pilot studies), including time for questions and answers. Then both the tutors and the tutees will take the test.

Forty will teach it by email. (All messages will be archived for analysis.) Twenty of these pairs will have no Q/C capability. Instructions, comments, questions and answers will be exchanged directly, as in ordinary written correspondence. The number of iterations will be chosen on the basis of pilot studies. After a specified number of iterations (to be chosen on the basis of pilot studies) both tutors and tutees take the test.

The remaining twenty pairs will be given the Q/C capability and will be instructed that all messages must take the form of comments on the fully requoted text of each preceding message. New text (in the form of questions, answers or comments) must be appended after each paragraph or part of a paragraph, after whichever passage the new text addresses. Some parts may be left uncommented, but the text in its entirety must be quoted. In requoting requotations, they will have the option of deleting prior requotations and requoting only the new passages from the immediately preceding iteration (but they will be able to retain several levels of embedded requotations if they wish). The same number of iterations will be allowed as in the non-quoting email group; then both tutors and tutees take the test.

Test performance will be compared for all seven groups. The prediction is superior performance for the quoting tutees over the nonquoting tutees. Higher scores are also predicted for tutors in general over those who take the test after professional instruction only. The oral vs. email comparison will be of interest, although there will be no strict way to equate oral instruction time with number of writtten iterations. In the data analysis, tutors' scores can be used as a covariate in the analysis of their respective tutees' scores, to reduce the effect of differences in level of tutors' comprehension of the subject matter.

It is expected that Q/C will result in superior performance, but it is unlikely that the task of students teaching other students newly aquired subject matter will be the central one for the Q/C capability. A series of further variables with which text-capturing is likely to interact will be tested as well. Each study is designed to be informative in its own right, and not only if the results go in one direction. Study 1 is a comparison of increasing degrees of interactivity in knowledge acquisition, from receiving passive oral instruction, to actively giving oral instruction, to giving and receiving written instruction, to full Q/C interactivity. Apart from the performance measures, the archived exchanges will be analysed to determine how Q/C capability influences the content of the interaction. Measures of relevance (Sperber & Wilson 1986) will be used to quantify the degree of divergence/convergence under the different experimental conditions.

Beginning with the pilot experiments for this study, the techniques used for Q/C and the format in which the quotes and comments appear will be adapted to the task and to the ease and preference of the users (Cavalier 1992;

Benbasat & Todd 1993; Hjalmarsson et al. 1989). There is no evidence that the most prevalent convention that has involved on the Internet -- left adjusted "> " preceding every line of direct quotation, usually inserted automatically by the mail program, and then modifiable only by invoking a full-text mail editor -- was selected because it was the optimal one, or even a good one. It seems to have emerged and spread spontaneously. Yet the optimal design for capturing and commenting on text is an important cognitive engineering question.

After each study, the participants will be interviewed for their recommendations about what features would have made the quoting/commenting easier and more useful to them. Each successive study, apart from its immediate experimental objective, will incorporate provisional improvements in Q/C display and control, but testing these formally must await the normative results of the basic studies on the cognitive contribution of Q/C in knowledge acquisition because the variance of the design factors is not likely to be of the same order of magnitude as that of the task and the Q/C variables.

Study 2:

A variant of the design of Study 1 will be implemented in the debating context, as opposed to the instructional context, because the Q/C feature is likely to be especially powerful in the development of arguments and counterarguments: In a pilot study, two groups of students will be prepared with arguments and evidence for defending a thesis (12 students) and an antithesis (12 students), respectively. Three pairs will then engage in an oral debate for a specified time period; their performance will then be rated by a panel of 6 experienced judges from the University Debating Society.

The other nine pairs will do a specified number of iterations of written debate. Half of them will have Q/C capability in their interactions, half not. There will be three subgroups of 3 pairs each: (1) Nonquoters (N) vs. Nonquoters, (2) Quoters (Q) vs. Quoters, and (3) Qs vs. Ns. As in Study 1, there will be an oral (O) debate control group. The performance of all the written groups will be scored by the same six judges, who will not be informed of the hypotheses being tested, but only that we would like them to rank order all 24 debaters, based on how well they defended their respective theses.

Participants will be recruited from the Debating Society of The University of Southampton. The numbers suggested are provisional, as it is not clear whether 24 individuals are too many to be rank-ordered. Pilot studies may show that a better design would be to have only one pair in each category, for a total of 4 pairs and eight individuals to rate. This could then be repeated for three or more groups, with the same judges. The number of written iterations will also have to be calibrated on the basis of piloting.

The prediction is that quoters will receive higher ratings than nonquoters overall, particularly when pitted against nonquoters. It will be of interest (though no prediction is made) to know how written (Q, N) vs. oral O) debaters are ranked overall. Participants themselves will be asked to indicate, before knowing the verdict of the judges, whether they felt they prevailed or lost. (A future variant within-subject design could use the same debaters, with different topics, performing in all five roles (O vs. O, Q vs. Q, N vs. N, Q vs. N and N vs. Q). Then judges could rate the same individual's performance (and the each of the individuals could rate his own performance) under each of the conditions.

The two experiments described so far, on the contribution of Q/C in the instructional and the debating context, begin to create a paradigm for evaluating objectively what this author and others are already informally trying out in the context of actual instruction, between real tutors and tutees (e.g., Hutchings et al. 1993; Brailsford & Davies 1995); Mayes & Neilson 1994; Rogers 1989; Poling 1994, Grigas 1994; Bailey & Cotlar 1994). Untested practical implementations have the disadvantage of not containing any objective basis for comparison, hence no way of validating the impression that something has been improved upon. As mentioned earlier, the experimental

context also provides a test-bed for working to improve the cognitive engineering of the features used. The experimental studies, and especially the pilot studies to calibrate the experimental parameters, will also be used to try out different methods for Q/C display, in search of the most effective one. Mouse-based methods, with automatic reformatting, indentation, type-face change, and quoter-identification will be investigated. The Media Research Group at Southampton University under Professor Wendy Hall will be contributing its expertise in these and other design aspects of the Project. See http://www.cogsci.soton.ac.uk/~harnad/Tp/rynne.html

Many-to-Many Email ("Skywriting") Interactions.

One-on-one interactions are only the first manifestation of the power of email interaction and Q/C. Reciprocal email ("skywriting," Harnad 1990), in which all contributors receive everything that is sent represent a truly revolutionary new form of communication (Harnad 1991; Harnad et al. 1976) whose potential still remains completely unexplored form a cognitive engineering standpoint, although it has already been informally and practically explored on the Internet in the form of thousands of discussion lists on Listserv and Newsgroups on Usenet. Here too, Q/C is in wide use, but its contribution has not yet been objectively investigated; nor has the optimal format for the Q/C and display been analysed.

Study 3 follows lines similar to the two Studies of 1-1 email, except that the discussion will be multiple and hence the degree of interactivity will be greater.

Study 3:

In a design similar to that of Study 1, eight modular topics will be taught to a class of 60 students under four conditions:

1. Two topics will be taught by ordinary oral instruction followed by ad libitum oral discussion in a separate tutorial session (10 students in each tutorial group).
2. Two topics will be taught by ordinary oral instruction; then each student will be required to contribute a specified number of oral questions, answers, or comments during the tutorial session.
3. Two topics will be taught only via email, the written instruction being transmitted to an alias list that reaches all the students in the course and is then immediately archived and made available on the World Wide Web in Hypermail (Belew & Rentzepis 1990) format for re-reading at will. Multiple email questions from students, and replies by both instructor and students, will also be transmitted by email to all, and archived on the Web as Hypermail. Students will be required to post a specified number of questions, answers, or comments by email, but without Q/C capability.
4. Two of the topics will only be taught via email sent to the class alias list and archived as Hypermail. Again, the students will be required to post a specified number of questions, answers, or comments by email, but with the Q/C format mandatory, as in Study 1.

The measure of performance will be quizzes for each module, as well as the students' subjective ratings and comments on the four conditions. The order of the conditions will not be random in this study, but 1 - 4 successively three times.

Here too, format optimisation questions arise, because many different potential quoters must now be uniquely and clearly identified in their respective quotes; scheduling problems also arise, because contributions can get out of phase, and someone might be quoting and responding to an earlier iteration while someone else is already responding to a later one. There are many variables in this new form of interaction that need to be analysed from the cognitive engineering standpoint. One potential solution is to archive all iterations consecutively in a hypermail

archive, so that all participants can readily review the prior iterations of the interaction. Hypermail as currently implemented is not optimised for any of this, but adaptations will be developed and tested in the context of this systematic analysis, again in collaboration with the Media Research Group.

(2c) Person-to-Text Interactions.

The hybrid use of Skywriting and Hypermail Archives on the World Wide Web probably represents the most advanced version of multiple person-to-person interaction currently, but the interactive power of Q/C does not stop with "live" email, 1-1 or multiple, for there is still the vast body of "inert" TEXTS (i.e., papers, articles and books) that can also be read (and written) using this new form of interactivity: These texts consist, potentially, of the entire corpus of written literature; for now, however, we are restricted to that portion of it that is already electronically available (and hence quotable). It is in part for this reason that we will be creating a cognitive science archive and developing and monitoring more powerful ways of interacting with it.

A natural next step in the experimental analysis of this form of interactiveness is accordingly to test the comprehension of static texts (as opposed to live email messages), with and without Q/C.

Study 4:

In a design similar to Study 3, twelve primary texts (journal articles in cognitive psychology of approximately equal length) will be assigned as reading to a class of 60 students under three conditions:

1. Two texts will be assigned for reading in paper and then alloted ad libitum oral discussion in a separate tutorial session (10 students in each tutorial group).
2. Two texts will be assigned for reading in paper; then each student will be required to contribute a specified number of oral questions, answers, or comments during the tutorial session.
3. Two texts will be assigned for reading in electronic form on the Web and then alloted ad libitum oral discussion during the tutorial session.
4. Two texts will be assigned for reading in electronic form and then each student will be required to contribute a specified number of oral questions, answers, or comments during the tutorial session.
5. Two texts will be transmitted via email to the class alias list and archived as Hypermail. Multiple email questions from students, and replies by both instructor and students, will also be transmitted by email to all, and archived on the Web as Hypermail. Students will be required to post a specified number of questions, answers, or comments by email, without Q/C capability.
6. Two texts will be transmitted and archived as above. Students will be required to post a specified number of questions, answers, or comments by email, but with the Q/C format mandatory.

The measure of performance will be quizzes for each module, as well as the students' subjective ratings and comments on the four conditions. The order of the conditions will not be random in this study, but 1 - 6 successively two times.

One last variable to explore will be interactive means of evaluation in place of conventional quizzes or essays. Texts will be made available electronically with instructions to reduce them to their essentials and annotate them. This form of electronic analysis of the text is so new that the only way to evaluate it initially is to compare it only with itself: to see how well the rank ordering of performance in this task compares with the rank ordering using conventional forms of evaluation. If it proves to correlate well with already validated measures of mastery, it might be considered as a form of evaluation in its own right.

Summary.

The results of the experiments on the cognitive role of electronic text-capturing should begin to validate, quantify and optimise the very new interactive capabilities that have emerged recently. They will pave the path for applying Q/C in education, research, as well as industrial knowledge acquisition.

Appendix

The Southampton Cognitive Sciences Eprint Archive

In 1991, a theoretical high-energy physicist called Paul Ginsparg (1994) contacted 100 colleagues with whom he had been exchanging paper preprints regularly and proposed exchanging them electronically instead. He set up a server in his Lab at Los Alamos, and all their preprints could be deposited there automatically, and then picked up automatically, by any of them.

From this small high-energy theory preprint depository, Ginsparg's archive has grown in four years into one that now contains more than half the current physics literature world-wide. It receives 350 new articles per week and is accessed 45,000 times per day by the world's 25,000 physicists, who no longer rely on paper journals for their information, but on this archive (duplicated in many "mirror" copies of it being created all over the world to distribute the load and ensure that everyone can always access everything promptly).

All of this is available world-wide, 24 hours a day, to everyone on the Internet for free. Dr. Ginsparg's archiving facilities are supported by an NSF grant that covers the cost of his server, software, and system support. The system is completely automatised, requiring minimal human intervention. Yet there are safeguards against tampering with other people's texts or frivolous uses of the archive.

The archive does not contain only the unrefereed preprints; authors substitute the refereed version (destined for a paper journal) as soon as it is available. No copyright issues have been raised by publishers, nor is it expected that they will be raised.

The archive has completely revolutionised the communication and publication of scientific information in the world physics community. The implications are still being sorted out, in negotiations with learned societies and publishers in these disciplines. What is clear is that an unprecedented and invaluable new service has been offered to the world physics community, and one that they have without hesitation come to rely on extremely heavily.

It is quite clear that the next step is to emulate Ginsparg's pioneering efforts in other disciplines. Ginsparg originally intended only to cover his own field of high energy theory, but the project very soon mushroomed to encompass the entire natural "module" of physics specialties. It makes much more sense for search and access purposes that these interrelated literatures be stored in a common comprehensive archive rather than in many different ones. So the expansion to include all of physics had a logic of its own.

The Cognitive Sciences (including large portions -- conceivably all -- of Computer Science and Engineering, Psychology, Neuroscience, Behavioral Biology, Linguistics and Philosophy) provide another natural focus for an comprehensive electronic archive.

The physics community had the advantage of already being (1) a preprint culture, accustomed to distributing and relying upon one another's work in (paper) preprint form prior to publication. They were also (2) a Tex culture, accustomed to preparing documents electronically in a standardised format for coding technical symbols.

The cognitive sciences have the advantage of being (1) intrinsically involved in the electronic medium (computer science created it and cognitive engineering is now analysing and optimising it) and (2) apart from the cognitive science subfields that likewise use Tex for technical symbols, a large portion of the literature is ascii (plain text), making it a much smaller step to transmit a copy of a text a cognitive scientist already has in his own word-processor to the central electronic preprint archive. The Ginsparg archive can automatically accept, store, and make available for screen display texts in the many standard word-processing packages in use today.

At Southamton we will accordingly implement in the Cognitive Sciences what Paul Ginsparg has created in Physics. As allies and resources in this undertaking we will have (1) the expertise of the Editor and Editorial Office of Behavioral and Brain Sciences (BBS) Journal, one of the leading paper journals in the cognitive sciences, (2) the Editor and Editorial Offices of BBS's electronic counterpart, Psycoloquy, the first refereed electronic journal in Psychology, (3) the Cognitive Sciences Centre at the University of Southampton, (4) the Multimedia Laboratory at the University of Southampton, with many of the most advanced resources and skills in the electronic display, research and retrieval of scholarly and scientific documents, and (5) the help and guidance of Paul Ginsparg himself, who has agreed to make his system available to us. We, in turn, have the opportunity to enhance the capabilities of the electronic archive itself, and future ones modeled on it, with features such as Microcosm, developed her

Microcosm is an open hypermedia link service. The project is well-known in the international research community and the software has recently been released as a commercial product. Microcosm allows its users to integrate any disparate pieces of information into a cohesive web of documents, which can then be viewed with the user's everyday applications (word-processors, spreadsheets, databases etc.). The system provides additional functionality in the form of a communicating set of processes that control and relate the individual documents.

Two of Microcosm's most powerful features are its ability to effectively overlay links onto any document, irresepective of its type, and the fact that it is constructed from a collection of simple processes working together. All links are stored separately from documents in link databases and link anchors can be content as well as location based. This means that links can be applied to documents over which the owner or author of the links has no write control, such as those commonly found on the Internet or on CD-ROM. Microcosm's flexibility means that new dynamic processes for link creation and/or resolution can be constructed and slotted into the system very easily.

The archiving component of the project has many potential benefits (Heseltine 1994; Odlyzko 1994). If it follows the example of the Physics Archive, it will become an extremely widely known and and widely used resource for all the disciplines involved. In generalising what has happened with the Physics archive to other disciplines, it will hasten the advent of a global scholarly/scientific archive (Harnad 1995). It will also help to guide the paper publishing industry in the direction where their expertise can be applied in future. As a European project (the Physics Archive having been an American one) it will put the UK in the front ranks of the revolutionary developments in academic publication and communication. And it will make the cognitive science literature available electronically for cognitive engineering analyses and applications of the kind that follow below.

The literature will be attracted to the Archive by a series of Calls and Postings, inviting cognitive scientists to deposit their e-prints in the archive, and stressing the advantages (very high visibility; permanent, instant, global accessibility; text-capturability, for feedback, comments and quoting in other work; no need to pay to circulate preprints or reprints; speed; etc.). The Physics archive grew very rapidly without the need of any prompting, yet we will attempt to facilitate the process even more with regular Calls, as well as by publicising the availability of the cognitive science literature through the archive. Taxonomic indexes and keyword searching capabilities are provided by the Los Alamos system already, but these too will be enhanced to make them more useful to the world cognitive science community. The objective is also to provide a model that other fields, including commercial ones, can follow. [See Cogprints: http://cogprints.soton.ac.uk/]

Summary:

In this essay I have suggested that the on-line text-capturing and quote/commenting (Q/C) and self-archiving capability that has emerged in the last two decades has created the possibility of combining the discipline and reflectiveness of writing with the speed and interactiveness of speech in a form of interactive cognition that is sui generis and without precedent in human discourse and inter-mentation. Whether with a live interlocutor or just an inert text, the interaction can now take place at the brain-friendly, on-line speed of thought, rather than at the lamentably slow, off-line turnaround time that paper communication had dictated. A series of experiments is described that will analyse and quantify the effects of Q/C interaction, both between people and between people and texts. In the interests of developing a textual corpus on which to base this revolutionary new form of interaction, what better course of action can the scholarly/scientific community take than to make its all-important refereed research record freely accessible online to one and all, for open-ended cycles of skywriting and skyreading, forever?

REFERENCES

Bailey, Elaine K.; Cotlar, Morton. Teaching via the internet. Communication Education, 1994 Apr, v43 (n2):184-193.

Belew, R.K.; Rentzepis, J. HyperMail: treating electronic mail as literature. SIGUCCS Newsletter, Winter 1990, vol.20, (no.4):26-31.

Benbasat, I.; Todd, P. An experimental investigation of interface design alternatives: icon vs. text and direct manipulation vs. menus. International Journal of Man-Machine Studies, March 1993, vol.38, (no.3):369-402.

Berge, Z.L.; Collins, M. Life on the net. EDUCOM Review, March-April 1994, vol.29, (no.2):11-14.

Blaye, A & Light P. Collaborative problem-solving with HyperCard: The influence of peer interaction on planning and information handling strategies. In O'Malley, C. (ed.) Computer Supported Collaborative Leraning. Heidelberg: Springer Verlag 1994

Bolter, J.D. (1991). Writing space: The computer, hypertext, and the history of writing. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Brailsford TJ & Davies, PMC Collaborative Learning On Networks (Proceedings of Conference on Computer Assisted Learning, Queens College, Cambridge 1995, in press)

Carley K; Wendt K. Electronic mail and scientific communication - A study of the SOAR extended research group. Knowledge-Creation Diffusion Utilisation, 1991 V12 N4:406-440.

Cavalier, R.J. Course processing and the electronic agora: redesigning the classroom. EDUCOM Review, March-April 1992, vol.27, (no.2):32-7.

D'Souza, P.V. E-mail's role in the learning process: a case study. Journal of Research on Computing in Education, Winter 1992, vol.25, (no.2):254-64.

Davis, H.C., Knight, S. & Hall, W. "Light Hypermedia Link Services: A Study of Third Party Application Integration". In the Proceedings of ECHT'94, ACM Press, pp 41 - 50 (1994)

Diederich, J.; Thummel, A.; Bartels, E. Recurrent and feedforward networks for human-computer interaction. IN: ECAI 92. 10th European Conference on Artificial Intelligence Proceedings. (ECAI 92. 10th European Conference on Artificial Intelligence Proceedings, Vienna, Austria, 3-7 Aug. 1992). Chichester, UK: Wiley, 1992. p. 206-7.

Dunbar, R. (1993) Coevolution of neocortical size, group size and language in humans. Behavioral and Brain Sciences 16: 681-736.

Ginsparg, P. (1994) First Steps Towards Electronic Research Communication. Computers in Physics. (August, American Institute of Physics). 8(4): 390-396. http://xxx.lanl.gov/blurb/

Golden, Peggy A.; Beauclair, Renee; Sussman, Lyle. Factors affecting electronic mail use. Computers in Human Behavior, 1992 Winter, v8 (n4):297-311.

Grigas, G. Distance teaching of informatics: motivations, means, and alternatives. Journal of Research on Computing in Education, Fall 1994, vol.27, (no.1):19-28.

Hall, W. Ending the tyranny of the button. IEEE Multimedia, Spring 1994, vol.1, (no.1):60-8.

Hall, W., Carr, L.A., Davis, H.C. & Hollom R.J."The Microcosm Link Service and its Application to the World Wide Web". In the Proceedings of the First International World Wide Web Conference, Geneva, May 1994, pp 25 - 34 (1994)

Harnad, S. (1979) Creative disagreement. The Sciences 19: 18 - 20.

Harnad, S. (1984) Commentaries, opinions and the growth of scientific knowledge. American Psychologist 39: 1497 - 1498.

Harnad, S. (1985) Rational disagreement in peer review. Science, Technology and Human Values 10: 55 - 62.

Harnad, S. (1986) Policing the Paper Chase. (Review of S. Lock, A difficult balance: Peer review in biomedical publication.) Nature 322: 24 - 5.

Harnad, S. (1990) Scholarly Skywriting and the Prepublication Continuum of Scientific Inquiry. Psychological Science 1: 342 - 343 (reprinted in Current Contents 45: 9-13, November 11 1991). http://cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad90.skywriting.html

Harnad, S. (1991) Post-Gutenberg Galaxy: The Fourth Revolution in the Means of Production of Knowledge. *Public-Access Computer Systems Review* 2 (1): 39 - 53 (also reprinted in PACS Annual Review Volume 2 1992; and in R. D. Mason (ed.) Computer Conferencing: The Last Word. Beach Holme Publishers, 1992; and in: M. Strangelove & D. Kovacs: Directory of Electronic Journals, Newsletters, and Academic Discussion Lists (A. Okerson, ed), 2nd edition. Washington, DC, Association of Research Libraries, Office of Scientific & Academic Publishing, 1992); and in Hungarian translation in REPLIKA 1994; and in Japanese in "Research and Development of Scholarly Information Dissemination Systems" 1994-1995. http://cogsci.soton.ac.uk/harnad/Papers/Harnad/harnad91.postgutenberg.html

Harnad, S. (1992) Interactive Publication: Extending American Physical Society's Discipline-Specific Model for Electronic Publishing. Serials Review, Special Issue on Economics Models for Electronic Publishing, pp. 58 - 61. http://cogsci.soton.ac.uk/harnad/Papers/Harnad/harnad92.interactivpub.html

Harnad, S. (1994) A Subversive Proposal. In: Ann Okerson & James O'Donnell (Eds.) Scholarly Journals at the Crossroads: A Subversive Proposal for Electronic Publishing. Washington, DC., Association of Research Libraries, June 1995.
http://www.arl.org/scomm/subversive/toc.html

Harnad, S. (1995a) The PostGutenberg Galaxy: How to Get There From Here. Information Society 11(4) 285-292. Also appeared in: Times Higher Education Supplement. Multimedia. P. vi. 12 May 1995
http://cogsci.soton.ac.uk/~harnad/THES/thes.html

Harnad, S. (1995b) Sorting the Esoterica from the Exoterica: There's Plenty of Room in Cyberspace: Response to Fuller. Information Society 11(4) 305-324. Also appeared in: Times Higher Education Supplement. Multimedia. P. vi 9 June 1995
http://cogsci.soton.ac.uk/~harnad/THES/harful1.html

Harnad, S. (1995d) Electronic Scholarly Publication: Quo Vadis? *Serials Review* 21(1) 70-72 (Reprinted in *Managing Information* 2(3) 1995).
http://cogsci.soton.ac.uk/harnad/Papers/Harnad/harnad95.quo.vadis.html

Harnad, S. (1996) Implementing Peer Review on the Net: Scientific Quality Control in Scholarly Electronic Journals. In: Peek, R. & Newby, G. (Eds.) *Scholarly Publishing: The Electronic Frontier.* Cambridge MA: MIT Press. Pp 103-108.
http://cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad96.peer.review.html

Harnad, S. (1997a) How to Fast-Forward Serials to the Inevitable and the Optimal for Scholars and Scientists. Serials Librarian 30: 73-81. http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad97.learned.serials.html (Reprinted in C. Christiansen & C. Leatham, Eds. Pioneering New Serials Frontiers: From Petroglyphs to CyberSerials. NY: Haworth Press, and in French translation as Comment Accelerer l'Ineluctable Evolution des Revues Erudites vers la Solution Optimale pour les Chercheurs et la Recherche http://www.enssib.fr/eco-doc/harnadinteg.html

Harnad, S (1997b) The Paper House of Cards (And Why It is Taking So Long to Collapse). Ariadne 8: 6-7. Longer version
http://cogsci.soton.ac.uk/harnad/Papers/Harnad/harnad97.paper.house.ariadne.html

Harnad, S. (1997c) Learned Inquiry and the Net: The Role of Peer Review, Peer Commentary and Copyright. Learned Publishing 11(4) 283-292. Short version appeared in 1997 in Antiquity 71: 1042-1048. Excerpts also appeared in the University of Toronto Bulletin: 51(6) P. 12. http://citd.scar.utoronto.ca/EPub/talks/Harnad_Snider.html
http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad98.toronto.learnedpub.html

Harnad, S. (1998a) For Whom the Gate Tolls? Free the Online-Only Refereed Literature. American Scientist Forum. http://amsci-forum.amsci.org/archives/september98-forum.html
http://www.cogsci.soton.ac.uk/~harnad/amlet.html

Harnad, S. (1998b) On-Line Journals and Financial Fire-Walls. Nature 395(6698): 127-128 http://www.cogsci.soton.ac.uk/~harnad/nature.html

Harnad, S. (1998/2000) The invisible hand of peer review. *Nature* [online] (5 Nov. 1998) http://helix.nature.com/

webmatters/invisible/invisible.html
Longer version in *Exploit Interactive* 5 (2000):
http://www.exploit-lib.org/issue5/peer-review/
http://www.cogsci.soton.ac.uk/~harnad/nature2.html

Harnad, S. (1999a) The Future of Scholarly Skywriting. In: Scammell, A. (Ed.) "i in the Sky: Visions of the information future" Aslib, November 1999
http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad99.aslib.html

Harnad, S. (1999b) Free at Last: The Future of Peer-Reviewed Journals. D-Lib Magazine 5(12) December 1999 http://www.dlib.org/dlib/december99/12harnad.html

Harnad, S. (1999c) Advancing Science By Self-Archiving Refereed Research. Science dEbates [online] 31 July 1999.
http://www.sciencemag.org/cgi/eletters/285/5425/197#EL12

Harnad, S. (2000a) E-Knowledge: Freeing the Refereed Journal Corpus Online. *Computer Law & Security Report* 16(2) 78-87. [Rebuttal to Bloom Editorial in Science and Relman Editorial in New England Journal of Medicine]
http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad00.scinejm.htm

Harnad, S. (2000b) Ingelfinger Over-Ruled: The Role of the Web in the Future of Refereed Medical Journal Publishing. The Lancet Perspectives 256 (December Supplement): s16.
http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad00.lancet.htm

Harnad, S., Carr, L. & Brody, T. (2001) How and Why To Free All Refereed Research From Access- and Impact-Barriers Online, Now.
http://www.cogsci.soton.ac.uk/~harnad/Tp/science.htm

Harnad, S. (2001) AAAS's Response: Too Little, Too Late. *Science dEbates* [online] 2 April 2001.
http://www.sciencemag.org/cgi/eletters/291/5512/2318b
Fuller version:
http://www.cogsci.soton.ac.uk/~harnad/Tp/science2.htm

Harnad, S. (2001) The Self-Archiving Initiative. *Nature* 410: 1024-1025
http://www.cogsci.soton.ac.uk/~harnad/Tp/nature4.htm
*Nature WebDebates*version:
http://www.nature.com/nature/debates/e-access/index.html
Fuller version:
http://www.cogsci.soton.ac.uk/~harnad/Tp/selfarch.htm

Harnad, S. (2001) The Self-Archiving Alternative. *Nature WebDebates*
http://www.nature.com/nature/debates/e-access/index.html
http://www.cogsci.soton.ac.uk/~harnad/Tp/nature3.htm

Harnad, S. (2001) The (Refereed) Literature-Liberation Movement. *New Scientist*.
http://www.cogsci.soton.ac.uk/~harnad/Temp/newsci1.htm
Fuller version:
http://www.cogsci.soton.ac.uk/~harnad/Temp/newscientist.htm

Harnad, S. (2001) Research Access, Impact and Assessment. *Times Higher Education Supplement*. http://www.cogsci.soton.ac.uk/~harnad/Tp/thes1.html

Harnad, S. & Carr, L. (2000) Integrating, Navigating and Analyzing Eprint Archives Through Open Citation Linking (the OpCit Project). Current Science 79(5): 629-638. http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad00.citation.htm http://www.iisc.ernet.in/~currsci/sep102000/629.pdf

Harnad, S. & Hemus, M. (1997) All or None: there Are No Stable Hybrid or Half-Way Solutions for Launching the Learned Periodical Literature in the PostGutenberg Galaxy In Butterworth, I. (Ed.) The Impact of Electronic Publishing on the Academic Community. London: Portland Press. http://cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad97.hybrid.pub.html

Harnad, S., Varian, H. & Parks, R. (2000) Academic publishing in the online era: What Will Be For-Fee And What Will Be For-Free? Culture Machine 2 (Online Journal) http://www.cogsci.soton.ac.uk/~harnad/Temp/Varian/new1.htm http://culturemachine.tees.ac.uk/frm_f1.htm

Hayes, P., Harnad, S., Perlis, D. & Block, N. (1992) Virtual Symposium on Virtual Mind. *Minds and Machines* 2(3) 217-238. http://cogsci.soton.ac.uk/harnad/Papers/Harnad/harnad92.virtualmind.html

Harnad, S. (ed.) (1982) Peer commentary on peer review: A case study in scientific quality control, New York: Cambridge University Press.

Harnad, S. (ed.) (1987) Categorical Perception: The Groundwork of Cognition. New York: Cambridge University Press. http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad87.cpreview.html

Harnad, S., Steklis, H. D. & Lancaster, J. B. (eds.) (1976) Origins and Evolution of Language and Speech. Annals of the New York Academy of Sciences 280. http://www.nyas.org/

Heseltine, R. A critical appraisal of the role of global networks in the transformation of higher education. Alexandria, 1994, vol.6, (no.3):159-71.

Hill, G., Wilkins, R. & Hall, W. "Open and Reconfigurable Hypermedia Systems: A Filter Based Model" Hypermedia, Vol 5, No. 2, pp 103-118 (1993).

Hill, G.J. & Hall, W. "Extending the Microcosm Model to a Distributed Environment". In the Proceedings of ECHT'94, ACM Press, pp 32 - 40 (1994)

Hjalmarsson, Ann; Oestreicher, Lars; Waern, Yvonne. Human factors in electronic mail system design. Behaviour & Information Technology, 1989 Nov-Dec, v8 (n6):461-474.

Holden, M.; Mitchell, W. The future of computer-mediated communication in higher education. EDUCOM Review, March-April 1993, vol.28, (no.2):31-7.

Holden, M.C.; Wedman, J.F. Future issues of computer-mediated communication: the results of a Delphi study. Educational Technology, Research and Development, 1993, vol.41, (no.4):5-24.

Horowitz, Rosalind, ed.; Samuels, S. Jay, ed. Comprehending oral and written language. Academic Press, Inc; San Diego, CA, US, 1987.

Hutchings, G.A.; Hall, W.; Colbourn, C.J. Patterns of students' interactions with a hypermedia system. Interacting with Computers, Sept. 1993, vol.5, (no.3):295-313.

Kemp, F. Emphasizing rhetorical effectiveness through computer networks. (Computer Support for Collaborative Learning Workshop, IL, USA, 4-6 Oct. 1991). SIGCUE Outlook, Spring 1992, vol.21, (no.3):29-31.

Lea, Martin, ed. Contexts of computer-mediated communication. Harvester Wheatsheaf; London, England, 1992.

Light, P & Butterworth, G. Eds. Context and cognition: Ways of learning and knowing. The developing body and mind. Lawrence Erlbaum Associates, Inc, Hillsdale, NJ, US. 1992. p. 134-156.

Light, Paul; Littleton, Karen; Messer, David; Joiner, Richard. Social and communicative processes in computer-based problem solving. Special Issue: Adult practices and children's learning: Communication and the appropriation of cultural tools. European Journal of Psychology of Education, 1994 Jun, v9 (n2):93-109.

Mayes, JT & Neilson, I. Learning from other people's dialogues: Questions about computer-based answers. Nantes JFIP Conference 1994 (in press)

McCarthy JC; Monk AF. Measuring the quality of computer-mediated communication. Behaviour & Information Technology, 1994, V13 N5:311-319.

McKnight, C., Dillon, A., and Richardson, J. (Eds.) (1993). Hypertext: A psychological perspective. Chichester: Ellis Horwood.

Odlyzko, A.M. (1995) Tragic loss or good riddance? The impending demise of traditional scholarly journals, International Journal of Human-Computer Studies (formerly International Journal of Man-Machine Studies), to appear. Condensed version to appear in Notices of the Amercan Mathematical Society, January 1995. http://www.research.att.com/~amo/doc/complete.html

Poling, D.J. E-mail as an effective teaching supplement. Educational Technology, May-June 1994, vol.34, (no.5):53-5.

Rogers, Gil. Teaching a psychology course by electronic mail. Social Science Computer Review, 1989 Spring, v7 (n1):60-64.

Romiszowski, A.J. Computer mediated communication and hypertext: the instructional use of two converging technologies. Interactive Learning International, Jan.-March 1990, vol.6, (no.1):5-29.

Searle, J. (1980) Minds, brains and programs. Behavioral and Brain Sciences 3: 417-457.

Sein, Maung K.; Robey, Daniel. Learning style and the efficacy of computer training methods. Perceptual & Motor Skills, 1991 Feb, v72 (n1):243-248.

Shedletsky, L. Minding computer-mediated communication: CMC as experiential learning. Educational Technology, Dec. 1993, vol.33, (no.12):5-10.

Sperber, D & Wilson, D Relevance : communication and cognition Oxford : B. Blackwell, 1986.

Sproull, L. and Kiesler, S. (1991). Connections: New ways of working in the networked organization. Cambridge, Mass.: MIT Press.

Steklis, H.D. & Harnad, S. (1976) From hand to mouth: Some critical stages in the evolution of language. In: Harnad et al. 1976, 445 - 455. http://www.cogsci.soton.ac.uk/~harnad/Papers/Harnad/harnad76.hand.html

Van Dijk, Jan A. The mental challenge of the new media. Medienpsychologie: Zeitschrift fur Individual- & Massenkommunikation, 1993 Mar, v5 (n1):20-45.

Wittgenstein, L. (1953) Philosophical investigations. New York: Macmillan Interactive Cognition: Developing and Analysing Electronic Capabilities