PSI AND HUMAN FACTORS: THE ROLE OF PSI IN HUMAN-EQUIPMENT INTERACTIONS

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Introduction

In recent years parapsychology has become more actively involved in building connections between its limited but growing body of knowledge and the knowledge bases of more orthodox areas of endeavor. In the last few years, Parapsychology Foundation conferences have dealt with the conceptual and empirical links between parapsychology and anthropology (Angoff and Barth, 1974), quantum physics (Oteri, 1975), education (Shapin and Coly, 1976), philosophy (Shapin and Coly, 1977), states of awareness (Shapin and Coly, 1978), the mind/brain relationship (Shapin and Coly, 1979) and communication (Shapin and Coly, 1980). By building links to various disciplines we come to see parapsychology as an interdisciplinary problem area, able to integrate with our current understanding of the world and in turn to enhance that understanding. As Alcock (1982) and others have argued, parapsychology's acceptance in part depends on its ability to help solve lingering problems in various disciplines. This suggests that we should explore poorly understood phenomena from other areas of science to assess the likelihood that psychic functioning of some sort is involved. The present paper considers a problem area within human engineering, or human factors, and discusses a new line of research aimed at assessing the role of psi.

Background

Human-equipment interaction in the past has involved users who were self-selected and well-trained for technical competence. Today, computers and computer-controlled equipment are becoming involved in a wide range of workplace environments. With this increased involvement comes acknowledgment that computer systems now involve users ranging in sophistication from the skilled programmer and systems analyst to the naive end user. Correspondingly, human factors considerations are increasingly relevant in maintaining and enhancing overall system performance (e.g., Bailey, 1982; 1983).

As system complexity increases, it becomes more difficult to determine sources of failure with precision. This is especially true of erratic or short-lived malfunctions. In computer systems such malfunctions can range from total system "crashes" to minor "glitches" such as temporary failure of a modem to carry a signal. Some failures have their sources in hardware or software problems specific to the condition of the system as a whole at the time of the failure, a condition that may be impossible to recreate if enough diverse users at separate ports are involved. Certain erratic hardware-related malfunctions involve sets of weak components of fluctuating strength, such that malfunction occurs only when their collective strength falls below a minimum acceptable level. Thus, there is less predictability about their performance and failure source cannot be effectively isolated to one component. Another major source of erratic functioning is undetected human error, especially among novice or incompetent users. The specific nature of the error often remains unknown—the error is only made once, or rarely and, when observed by an expert, the novice carries out the procedures more carefully.

However, some erratic malfunctions appear to cluster around certain users and/or circumstances, in ways that seem to be anomalous. They appear not to be traceable to presently understood hardware, software or human error sources, yet happen with sufficient consistency to indicate a real functional relationship between user condition and machine functioning. Marks and Kammann (1980) refer to this phenomenon as the "gremlin effect," noting that it is widely reported, but may well be merely an artifact of our tendency to remember selectively events that seem anomalous, thus exaggerating their consistency. If the "gremlin effect" is merely the product of artifacts, we need to understand the artifacts in detail as they apply to the workplace situations in which they arise. If the effect is real, however, and user condition can contribute in additional, nonobvious ways to system performance, we must discover the principles involved through systematic observation and experimental protocol.

The Problem in Detail

Three lines of evidence can be offered for psi factors in human-equipment interaction. Considered together they suggest a research strategy for assessing its validity and, if valid, learning its nature.

Anecdotal evidence. There is considerable informal lore linking certain kinds of people and workplace circumstances with deviant system performance. In recent years several studies have found significant differences in the personality characteristics of people with high versus low accident involvement (Studt, 1977; Fernandez-Seara, 1978; Satler, 1980). In India, drivers with a high incidence of traffic accidents show a tendency toward introversion, high neuroticism, low confidence level and low self-esteem (Pestonjee, Singh and Singh, 1980), characteristics also found to be associated with psi-missing in the parapsychology laboratory (Palmer, 1977). Perhaps such people make ESP-mediated poor decisions leading to accidents, or psychically influence labile components of equipment around them to induce damaging malfunctioning.

Certain people acquire a reputation for equipment tending to function poorly around them (malfunction-linked people, or MLP's). They may be actual operators of equipment or general users involved less directly with physical contact with the equipment, such as supervisors. Some are linked thusly with equipment in general; others appear to be specialists in certain kinds of equipment such as cameras, watches, copying machines, telephones and computers. In extreme cases such people become known as carriers of bad luck, jinxes, Jonahs, hoodoos and so on. Such people generally express a negative attitude toward the equipment. Gamow (1959) describes the "Pauli Effect" as follows: "It is well known that theoretical physicists are quite inept in handling experimental apparatus; in fact, the standing of a theoretical physicist is said to be measurable in terms of his ability to break delicate devices merely by touching them. By this standard Wolfgang Pauli was a very good theoretical physicist; apparatus would fall, break, shatter or burn when he merely walked into a laboratory." Others have the opposite reputation, in that everything seems to function well around them. When they try to fix something it either gets fixed easily or else no longer malfunctions at all in their presence. Such people are function-linked people, or FLP's.

According to the informal lore we have been collecting, anomalous malfunctions seem to occur under circumstances likely to induce stress in workers considerably above the stress levels optimum for efficient performance. Computer salespeople tell of making sales pitches and having their systems crash just when the top brass walks into the room, i.e., when there's a sudden shift in the stress level. Maintenance and installation people tell of being able to identify certain kinds of offices for which the installation is going to be difficult, or for which the repair rate is going to be high, e.g., offices in which the social structure produces tension or where key personnel really do not wish the new piece of equipment to be installed.

Experimental research on observer influence upon the behavior of known sources of noise, or random number generators (RNG's). Considerable evidence has accumulated that experimental subjects can statistically affect the behavior of RNG's whose output is converted to a string of bits that then affects something of importance to the subject (Stanford, 1977; Rush, 1977; 1982; Schmeidler, 1977; 1982). In such studies the bit string is used to drive a display of some sort, generally visual, but occasionally auditory. At the same time the bit string is tallied automatically. A subject is shown the display and is asked to bias its behavior in some systematic fashion. Significant findings have been found in at least fifteen different laboratories in this and other countries.

One general trend in this work is that success at influencing sources of randomness appears to be high whenever the subjects have been encouraged to be relaxed and are in non-stressful situations, such that they are not striving hard to affect the source of randomness (Stanford, 1977). On the other hand, striving too hard may produce either chance or below-chance results (e.g., Thouless, 1951; Zusne and Jones, 1982).

We did a study designed to assess the generality of this notion (Debes and Morris, 1982). Subjects in a sound-attenuated, electrically-shielded room observed a television display controlled by a source of randomness hardwired into an LSI-11 computer in an adjoining room. At the start of each run a dot appears at the top of the screen and a trail of dots gradually extends to the bottom of the screen. Each dot is one step towards the right or the left of the one immediately above it, depending on the RNG output. The subject's task is to push the trail of dots to one specific side. Half are asked to push it to the right side; the other half to the left side.

For the study in question, half our subjects were given a non-striving instructional set: "Get relaxed, lean back in the chair and take your shoes off if you like. When you open the packet which reveals what your target direction is, bear it in mind, but remember there is such a thing as trying too hard. Keep your attention on the display, but don't be too concerned about how well you are doing. This is your opportunity to cooperate with the computer, to help the line go in the direction you want it to." The other half were given a striving instructional set: "This is your chance to beat the computer, to compete with it, to win out. If you want to, stand up, move your arms around, yell at it, be forceful with it. The line down the middle lets you know how well you are doing as the dots trail down the screen. The lines off to the side indicate how strongly your results deviate from chance."

Our study involved 32 university undergraduates; 13 of the 16 given the striving instructions scored below chance, whereas 14 of the 16 given the non-striving instructions scored above chance. The difference between the two groups was quite significant statistically ($p \leqslant .001$). Within each of these groups, half of our subjects had been self-rated as high competitive and the other half low-competitive. Level of competitiveness did not appear to affect these results.

Much further research is needed to establish the generality and applicability of this finding. It does support the notion that PK mediated equipment malfunctioning may be more likely to occur in circumstances in which there is competitive pressure placed on people to perform, especially with unfamiliar equipment. It also supports the notion that PK effects can lead both to enhanced system performance (e.g., consonant with operator intention) and degraded performance.

Braud (1981) summarized a variety of studies in which psi effects seemed strongest when the PK target was what he called a labile rather than inert system. He defines lability as "characterized by a ready capability for change" and inertia as "the tendency of a system to resist change and to continue in its present condition, whether that condition be rest or motion." If Braud's notion is correct, we would expect more evidence for PK-mediated human-equipment interaction to occur in equipment having relatively high lability, such as old or poorly constructed equipment. Sources of noise, such as RNG's, are of course deliberately constructed to have high lability.

Unexpected System Failures in the Laboratory. Anecdotes are flawed as evidence because they involve real-world incidents noted and recorded after the fact, without the kinds of controls that allow confident interpretation. Laboratory studies may have adequate controls, but are generally artificial situations that provide no guarantee of generalizability to real-world circumstances. Recently, however, a set of unexpected erratic computer failures occurred in our own laboratory under conditions that were well-controlled, yet were very much a real-life circumstance for the researchers and subjects involved. While conducting a followup to our earlier study, we found that periodically, yet unpredictably, our computer system was crashing in the middle of an experimental session, such that we had to abort the experimental session. By the end of the semester we had crashes for 13 of the 33 subjects we had attempted to run. We took apart the system and found that the newly installed interface board for our hard disk unit was responsible. The experiment continued the following term until the intended total of 64 subjects was reached, but only with the use of floppy disk storage units; its results were at chance (Morris and Courtney, in preparation).

The computer failures had had no pattern to them that we could discern. Some faulty component or set of components apparently was occasionally entering a state which brought the system down, through one of the safety mechanisms designed to avoid damaged data processing. The failures were random enough that we began to wonder whether our subjects might not be influencing the behavior of the faulty component(s). We realized that all subjects had previously filled out a questionnaire, which we could use to examine the characteristics of those associated with the computer failures. Bearing in mind the informal anecdotal lore mentioned earlier, we hypothesized that the subjects for whom the computer failed would be significantly more negative in their attitudes toward psi effects than those for whom the computer did not fail. Such was the case, to a marginally significant extent ($p < .05$). The computers were failing in the presence of people with negative attitudes about the endeavor they were engaged in. We also hypothesized that those for whom the computer failed would be significantly more inclined to anxiety in performance situations than those for whom the computer performed adequately. This hypothesis was also confirmed, to a marginally significant extent ($p < .05$). Performance anxiety proneness was measured by a component of our questionnaire, the Sports Competition Anxiety Test, or SCAT (Martens, 1977).

Thus, our computer system appeared to be failing in the presence of people who did not value what they were doing and who were inclined to be anxious about performance. We were unable to relate the crashes to how long the system had been on, to temperature, humidity, how it was being operated and so on. Subject competence was not relevant to equipment functioning—they passively observed the displays and did not physically interact with the computer system itself. Experimenter error would have shown up at the beginning of the session. We now have learned that a poorly made interface board had several minor manufacturing flaws. It was a subsystem which periodically had several factors summate to exceed a critical threshold and make it malfunction. The likelihood of such malfunction appeared to be related to the attitudes of the subjects involved. Thus, we had laboratory evidence of a direct, nonobvious relationship between noise-modulated equipment performance and user condition, suggestive of a PK effect upon a labile system.

Human-Equipment Interaction Anomalies from a Human Factors Framework

To guide our research, we need at least a beginning conceptual framework. Thus we have developed a set of working hypotheses, derived from past research in human factors and parapsychology and from anecdotal material.

Hypothesis I. Some people are consistently associated with unusually successful human-equipment performance, either in their own minds or in the minds of coworkers. Such people can be designated as Function-Linked People, or FLP's.

Hypothesis II. Some people similarly are consistently associated with unusually unsuccessful human-equipment performance and can be designated as Malfunction-Linked People, or MLP's.

Hypothesis III. Certain environments, both physical and social, are consistently associated with unusually successful or unsuccessful human-equipment performance. They can be referred to as Function-Linked Environments (FLE's) and Malfunction-Linked Environments (MLE's).

Hypothesis IV. Some of the factors responsible for such consistencies in human-equipment performance involve the conditions of the equipment itself, either as a whole or its components.

Hypothesis V. At least four kinds of personal factors are involved: basic competencies, such as psychomotor, sensory processing and cognitive abilities; general lifestyle characteristics such as those related to mental and physical health as well as work habits; familiarity with the equipment and task at hand, including prior training; and attitudes about both general and specific characteristics of the various components of the human-equipment interaction system.

Hypothesis VI. These four sets of personal factors may interact with each other as well as with equipment and environmental factors to affect performance.

Hypothesis VII. The effects of these factors may often be subtle, such as to escape the notice of observers. On such occasions observers may regard system performance as unusual, anomalous, or psychically mediated.

Hypothesis VIII. Observers may observe poorly, or misinterpret what they observe, or misremember what they observe, or impose too much pattern upon sets of observations, such as to attribute more causality between human and equipment than is actually there. On such occasions observers may mistakenly conclude that certain people or environments are anomalously linked with system performance.

Hypothesis IX. In addition to the above, psi input factors (ESP) are involved in human-equipment interaction, such as to enhance or degrade system performance. Equipment operators may psychically access information relevant to equipment functioning such as to affect which equipment they select to operate, when and where they decide to operate it and how they operate it. Decisions made in diagnosis and repair may also be psychically affected. Indirect users such as managers or customers may have their interactions with equipment-based systems affected in similar ways.

Hypothesis X. Psi output factors (PK) also affect human-equipment interaction and consequent system performance. Equipment operators and indirect users alike may psychically influence labile components of equipment, thereby enhancing or degrading performance.

Hypothesis XI. The degree and direction of psychic influence upon systems is affected by both state and trait personal factors, by physical and social environmental factors and by lability factors in the equipment itself.

These working hypotheses are far from complete and clearly need revision. Nevertheless, they can contribute to the organization of a cohesive research effort.

A Proposed Research Program

We propose three areas of research, each oriented toward eventual application.

Collecting anecdotal evidence. If we are to develop a research program to explore psi effects in human-equipment interactions, we need a good picture of the nature of the evidence for such effects drawn from real-life situations. Unfortunately, relevant anecdotal material is very scarce and tends to be scattered in different places rather than cohesively organized. For human-computer interaction it appears to be virtually nonexistent.

Scattered throughout the literature on poltergeists, there are occasional references to equipment-related effects. Perhaps the best documented case is the Rosenheim case (e.g., Bender, 1974), which included extensive, repeated malfunctioning of the telephone system in an office. Technicians with monitoring equipment were able to isolate a location in the system in which unexplained power surges were suddenly occurring and producing, as a result, unusual phenomena elsewhere in the system. Although equipment is occasionally involved in other poltergeist cases, there has been no attempt to collect equipment-related disturbances and analyze them as a separate category in which to look for patterns. It is frequently noted (e.g., Roll, 1970) that poltergeist phenomena tend to occur in the presence of a particular person, generally a young person and one with considerable strong negative emotions. Certainly the poltergeist case material as a whole needs further evaluation. Although the phenomena are frequently explainable in other physical terms, there is a residue of well-observed phenomena suggestive of large-scale PK effects.

There is considerable informal lore within the scientific community about individuals who have problems interacting with equipment. Perhaps the most notorious was Wolfgang Pauli (see Gamow quote above). The concept of the Jonah, jinx or hoodoo (analogous to the malfunction-linked person, or MLP) is common in the lore of many classes of workers, such as seamen, construction crews and so on. Within the study of folklore, a major category is the scapegoat, the individual held responsible for misfortune beyond that directly attributable to him. Folklore also involves the concept of contagious magic, the spread of influence by contact. The MLP seems to spread misfortune or negative influence simply by contact of some sort. Such lore needs to be collected and organized, as it relates specifically to human-machine interaction.

Some people cannot keep wristwatches functioning when they wear them. One acquaintance has gone through nineteen new watches. When the topic was brought up by us in public lectures, 5 percent of the audience indicated that they were unable to wear watches. Others have reputations for breaking cameras and photocopiers and for producing malfunctions in telephones and computers. Certain companies have notorious computer systems that are frequently out of order, costing the company considerable money. A computer repairer reports that on night shifts for a local company one special operator is always the one who calls in with repairs needed. It is our impression that the anecdotes are abundant, waiting to be collected and evaluated, so that we can know their relevance for our research and vice versa.

Although our focus is on human-computer interactions, we may want to collect a wider range of anecdotes, to get a broad picture of human-equipment interactions. There are several categories of anecdotal material of interest to us, each of which may call for a separate approach.

(1) *Situational stress with system.* We will look for anecdotes involving systems whose performance characteristics are well understood and not directly affectable by its operators. If the system tends to perform well when the situational stress of those involved is low (function-linked environment, or FLE), and tends to perform poorly when the situation stress of those involved is high (malfunction-linked environment, or MLE), this is evidence of a psi effect upon the system. An example would be a tendency for a university computer to crash more at finals time if, in fact, the characteristics of the usage were the same as during other times of the term.

(2) *Individual stress with system.* These anecdotes will be similar to those above except that system performance varies with whether or not individuals who are highly stress-prone are using it. The user stress

resides in the stable characteristics of the individual user rather than a general situation (e.g., exam time) likely to produce stress in all concerned. An example would be a driver training automobile which tends to break down whenever being driven by students who really don't want to learn to drive. Such effects of stressed individuals will probably be noticed in smaller systems, whereas situational stress affecting many users at once may be more likely to be felt in larger scale systems.

(3) *The malfunction-linked person (MLP).* These anecdotes involve individuals who are consistently linked, in their own minds and/or others', to malfunctions of systems with which they become involved. Ideal cases will involve systems in which the malfunctions are strong, rare and not obviously influenceable by the MLP's actions. There should be enough consistency to the malfunctions that they have come to be predicted rather than merely noticed after the fact. The MLP may be known for producing malfunctions in general or malfunctions only in certain kinds of equipment. An example would be the person who tried nineteen consecutive new watches without finding any that she could wear consistently.

(4) *The function-linked person (FLP).* These anecdotes parallel those in the preceding section. The FLP is consistently linked with smooth function of equipment, whether equipment in general or a specific kind of equipment. As noted much earlier, FLP's can be those who operate or observe the equipment, or those who repair it. An example would be the repair person in whose absence things seem to go wrong, but in whose presence equipment functions well. This category of anecdotes may be easier than the others to collect, since it involves successes rather than failures. It may also be less likely to be noticed, however.

Given that the anecdotes exist, it is not intuitively obvious just how to go about collecting them. We are dealing with factors that may affect sensitive, profit-related areas for companies. Such data as failure rates and their correlates may be regarded as secret information, useful to competitors if made public. Companies in the past have tended to solve many of their human-equipment interaction problems by destroying the equipment, firing or transferring the worker, canceling failure-prone relationships with other institutions and so on. It may be problematic to persuade institutions that the data we need can be gathered in ways that do not threaten the institution's functioning or reputation. When we deal in a public applied context, we may have to take special care in how we introduce ourselves, lest we appear to be intruding occult notions. Depending on the people involved, we could easily represent ourselves as exploring PK effects in human-equipment interactions, anomalous human-equipment interactions, problematic human-equipment interactions and so on. How we phrase ourselves may be the difference between cooperation and noncooperation.

Unfortunately, we will generally be asking people to describe circumstances in which something has gone wrong. Many are reluctant to remember such details or embarrassed to discuss them. If they do discuss them, often they may seek to place the responsibility for failure elsewhere, or take on too much responsibility for the failure themselves. In our interactions with individuals we would need to insure that they did not feel that their status would be threatened by providing us with an accurate description of events. There are many additional problems to be taken into account in any collection of anecdotal material, as we have surveyed elsewhere (Morris, 1982).

Some anecdotal material may be available from the human factors, sport and performance psychology or parapsychological literature. Anecdotes may also be recruited through public advertisements or special interest publications. Institutions and industries that maintain extensive operations data bases may have enough information to allow after-the-fact extraction of the personal, environmental and equipment factors most correlated with anomalous system performance. Computer-related industries could be approached about the possibility of joint human factors research on their products and how to improve their production processes and customer satisfaction. Surveys could combine questionnaires and interviews at the start, then move to the field investigation stage. Employees would be encouraged to keep detailed records of crucial aspects of human-equipment performance, focusing on select people, select pieces of equipment and select circumstances of high and low tension.

An additional group of interest is insurance companies. They may have considerable data on individuals they insure who are accident-prone, including the characteristics of circumstances that seem to foster accidents or economic loss due to equipment malfunction. Likewise, organizations dealing with workmen's compensation may have relevant data. Such organizations would be less likely to provide anecdotes, but could be a source of existing but overlooked data and would be well motivated to collect more extensive data in the future.

The introduction of high technology into social systems that are unfamiliar with it can produce considerable stress in those involved. Workers faced with learning the operation of equipment that is quite foreign to them are likely to be anxious and have negative attitudes—just the factors that seemed associated with computer failure in our own work. Some of the problems may be due to differences in attitudes between the technology exporters and importers. When equipment malfunctions occur, some exporters may be inclined to write off the problem in terms of trainee incompetence or deliberate carelessness, without probing further to understand the nature of the malfunctions and how they may be alleviated. Background library research is needed to assess whether a body of anecdotal material already exists. Then would come informal contact with members of corporations active in exporting technology to Third World countries, to explore whether they had malfunction problems in the field that might be amenable to cooperative investigation. Subsequently one would, if appropriate, proceed to the development of field investigations and controlled research.

In general, descriptions of human-equipment interaction anomalies gathered from such sources as the above would be used to generate a detailed, comprehensive research program to evaluate the role of psi, if any, in the production of such anomalies. In the next section we present an example of what a component of that program might look like.

A Specimen Experimental Study

We propose to create a simulated workplace environment in which users interact with small computer systems. The users/subjects will include both MLP's, people whom we expect to be associated with high rates of equipment malfunction, and FLP's, people expected to be linked with unusually efficient equipment performance. They will work part of the time under conditions linked with high rates of equipment malfunction and part of the time under conditions associated with efficient equipment performance. Variables associated with user condition will serve as independent variables.

The computer systems will be microcomputers interfaced with a minicomputer. Malfunction-prone components will be simulated by RNG's. The computers will be programmed to sample the output of the RNG's at periodic intervals. If the output shows a bias in excess of a preset criterion, the program will cause the computer to malfunction in some way. The RNG output and the RNG-induced computer failure rates will be dependent variables.

There will be two experimental tasks for subjects: (a) learn to operate the computer system in general and (b) learn to use specific software packages with the computer. Thus, an additional available set of dependent variables will be measurements of success at the learning tasks.

We will start by conducting a set of exploratory studies, comparing conditions in which we expect very high user-induced malfunction rates with those in which we expect very low rates. We will also manipulate RNG configurations, as described below, to learn which produce the strongest results.

Three groups of subjects will be involved: malfunction-linked people (MLP's), function-linked people (FLP's) and control subjects not linked with equipment performance. There will be two kinds of MLP's and FLP's: direct and hypothetical. Direct MLP's and FLP's are people recruited through questionnaires and interviews who have reputations for inducing frequent anomalous performance either in a variety of equipment in general or in computer-controlled systems in particular. We have developed a Technology Attitudes Questionnaire which is being administered to local student and industrial groups. Hypothetical MLP's and FLP's will be subjects whom we expect to be MLP's or FLP's for theoretical reasons. Hypothetical MLP's include people who: (a) have never used computers in any way before; (b) dislike or place low value upon high technology and computers; (c) dislike learning new things; (d) have low self-confidence and self-esteem; (e) are inclined to performance anxiety and (f) are inclined to externalize locus of control (e.g. Rotter, 1966; 1982). Hypothetical FLP's would in general have opposing characteristics. Control subjects will be selected as best as possible to be neutral in the above respects. Our measures for the above variables will be drawn from our Technology Attitudes Questionnaire plus the SCAT (Martens, 1977) and Rotter's Internal-External Scale (1966).

Subjects will be seated in comfortable straight-backed chairs at a worktable with a microcomputer. The room will be partially sound-attenuated, electrically shielded and well-lit. The minicomputer, RNG's and other equipment will be housed in a nonadjoining room.

A set of five RNG's will provide input to the microcomputer to produce random malfunctions. These malfunctions will include: bringing the system down completely; resetting to the start of the program; interruption; unwarranted error messages; user-hostile error messages; disruption of keyboard function; disruption of CRT display and excessive delay in response time. Additional hardware- and software-related malfunctions will also be developed.

Each RNG will produce a bit stream fed into a counter and from there into a filter/transducer. In filter mode, the bit stream for a preset time interval is tallied. If it deviates from randomness by a preset amount, then a decision to malfunction is fed into a second filter, the master filter. If the criterion to malfunction is set low, then the RNG will be functioning like a severely flawed component, likely to malfunction frequently. If set high, the RNG functions as a slightly flawed component that will malfunction more rarely. In transducer mode, the signal passed to the next stage is directly proportional to the deviation from chance. Such a signal can then be used to control directly the degree of a malfunction capable of varying continuously, such as delay in response time. The greater the deviation from chance of RNG output, the longer the delay time.

By having five RNG's feeding decisions into a master filter, we can simulate a variety of malfunctioning hardware systems, to explore which are most amenable to MLP and FLP user effects. Using only one RNG simulates a single-flaw system; using all five simulates a multiple-flaw system. The master filter can be set to transmit a malfunction decision if any one of the RNG's reaches criterion. It can be set to take a majority vote or it can be set to transmit malfunction only if all five RNG's have reached criterion. The RNG system is housed in the LSI-11 such that when a malfunction criterion is reached, the LSI itself interrupts the functioning of the microcomputer.

Our RNG's will be built initially in accordance with criteria developed by Chevako (1983). In followup studies, their properties will also be varied systematically to explore what kinds of physical noise systems appear most amenable to user effects. All RNG's will undergo rigorous pretesting before any experimental use.

To increase the likelihood of success, the experimental conditions will be manipulated to create situations which we expect to be linked with malfunctions and with positive functioning. Four stress-related conditions will be manipulated: (a) degree of task difficulty in terms of amount of material to be learned per unit time; (b) adequacy of introduction to the experimental task, in terms of experimenter's instruction and available help aids; (c) presence or absence of an evaluative observer and (d) presence or absence of experimenter-induced, non RNG-controlled equipment malfunctioning during the first quarter of the training period.

For MLP's, we predict more frequent malfunctions under the high stress conditions, e.g., high task difficulty, inadequate task instructions, presence of an evaluative observer and presence of induced equipment malfunctioning. For FLP's, we predict infrequent malfunctioning under the low stress conditions and variable malfunctioning under the high stress conditions. Some FLP's may find the high-stress conditions to be optimum for performance. We expect FLP's in general to have higher optimum performance stress levels than MLP's.

The deliberate induction of malfunctioning during the first quarter of the experimental session is of special interest as it bears on the notion of "learned helplessness" (Seligman, 1975; Miller and Norman, 1979). The learned helplessness model posits that individuals who learn that their own actions do not affect outcomes of importance to them (e.g., who learn that they are "helpless") will then generalize to later tasks in which they in fact can control outcomes, such that their performance level will be lower than that of control subjects. The present study allows us to begin exploring the relevance of learned helplessness for learning to operate computers. Those subjects for whom the computer malfunctions frequently during the first quarter of the session are learning helplessness—they are learning that their own actions, no matter how carefully thought out and executed, cannot prevent computer malfunctioning. During the last three quarters of the session they will have learned to expect computer malfunctioning over which they have no control. Thus we would expect more RNG-controlled malfunctions in the presence of those operators who have learned to expect them than for those operators who did not experience malfunctions during the first quarter of the session. We expect this result to be strongest for those who externalize locus of control, e.g., those who feel that what happens to them in general is not controlled by their own actions (Rotter, 1966). We also expect that actual performance in learning to operate the computer will be higher for all conditions in which we predict RNG-induced malfunctioning to be lower.

Any significant relationship between malfunction rate and user condition thus can be taken as indicating the presence of a nonobvious direct user effect. We would then undertake replication and extension of findings, emphasizing those variables most strongly related to malfunction rate and exploring differences in RNG-system variables to find which systems are most sensitive. Additional studies would be aimed at developing training techniques to convert MLP's into FLP's and to enhance the effectiveness of FLP's even further.

Since we are including actual learning success measures as independent variables, our studies will generate valuable information about user variables and computer training procedures regardless of whether or not any psi effects emerge from the data. We can then follow up on those results as well, to develop training techniques that optimize stress levels for different kinds of potential computer users.

Implications for Artificial Intelligence

Any discussion of psi-mediated interaction between human and computer would not be complete without reference to the implications for artificial intelligence. If people can improve computer performance by psychically affecting labile components, perhaps they also can improve a computer's problem solving performance. For the present, such discussion is based on possibilities that await empirical evaluation and is thus rather speculative. However, at least one set of possibilities would seem amenable to experimental investigation.

Suppose we find evidence that FLP's can bias the output of a bank of RNG's such as to avoid noise-related malfunctions. The noise in the computer would then have become an advantage rather than a disadvantage: although noise, it would have become "smart noise" when linked with an FLP. This leads us to two more hypotheses.

Hypothesis XII. Noise plus FLP plus FLE (function-linked environment) equals a "smart noise system." If the bit stream from such a system is interfaced with the information processing and decision making components of a computer system, it can bias the computer system to function more intelligently to execute the goals of the FLP.

Hypothesis XIII. Noise plus MLP plus MLE equals a "dumb noise system." Its bit stream, when interfaced with a computer system, will bias the computer to act against the goals of the MLP.

The situation would never be simple, however, and the above hypotheses need to be expanded and sharpened. There may be a mix of MLP's and FLP's, in a variety of environments, each having goals in mind for the computer system. As I have indicated elsewhere (Morris, 1981), such multiple-person systems may be analogous to the electoral college in finally determining a noise-driven event. Many people may contribute some to the process, but some would contribute little (like Delaware and Rhode Island) and some would contribute a great deal (like California and New York). Thus any research endeavor should probably focus on conditions strongly favoring "smart noise" or "dumb noise" and minimize circumstances conducive to complex interactive effects.

Applications in practical circumstances are difficult to anticipate without more understanding of the phenomena we are working with. Two possibilities illustrate the potential.

Example A: Robots occasionally confront situations not clearly specified in their programs, e.g., they cannot effectively monitor their environments and extract the data needed to select an appropriate course of action. This may be because they lack the relevant sensors or because they have inadequately sensitive sensors. Or, the output device of the robot (e.g., a grasping tool) may lack adequate fine movement skills. In such cases, the robot could be programmed to sample a "smart noise" source to replace or augment its sensorimotor devices. To insure that the FLP component was actually contributing to the bit stream, that stream could be sampled and analyzed for the "PK signature" (an idiosyncratic pattern in the stream) of that particular FLP before proceeding.

Example B: The main efforts of the artificial intelligence community are now being directed toward the production of "fifth generation" computers (Feigenbaum and McCorduck, 1983), which employ logic programming languages to execute literally millions of logical inferences per second (LIPS) to process complex data bases on-line and thus function as "expert systems" to assist in medical diagnosis, undersea well drilling and so on. Such systems function extremely well within the constraints of the logic of their programs. They combine information in logical ways and do not seek "creative" combinations that go against its conventional wisdom. By introducing "smart noise" at key places and times, we may be able to approximate the creative process more effectively for those situations when it is needed. Some computer-generated graphic art programs already use sources of noise to fix the exact selection of colors and locations of figure boundaries. Any introduction of noise in a logically organized information processor would introduce an element of risk and would need to be handled in the same ways as we deal with human "hunches." If we argue that human hunches may be psi-mediated in part, then "smart noise"-induced "hunches" may well share many of the same advantages and weaknesses.

These examples at present are speculative, but follow logically from our present understanding of PK effects as more goal-oriented than process-oriented and as not requiring conscious striving to be effective (Stanford, 1977). If "smart noise" can be harnessed effectively to augment existing human-computer interactions, then the sixth generation computer system may well become a system in which human and computer are truly partners, with a reemergence of emphasis on the human component and the human factors that affect our values and the rich qualities of human experience.

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DISCUSSION

ROLL: When the Swedish military administered the Defense Mechanism test it appeared that airmen who scored low on that test, who seemed to show a great deal of anxiety, defensiveness and so on tended to crash their planes sooner than the others. This might be information that you should look into. Then you mentioned the term *field* or *field of influence*. Perhaps this is an opportunity to study this field. In this type of work we seem to be dealing distinctly with a proximity factor which we have also noticed in RSPK. Have you any comments on such studies? Do they throw light on this proximity factor, on whether or not it is real? In addition to advancing our ability to understand and apply psychic interactions this might also be a very interesting area for understanding the modus operandi of psi.

MORRIS: Yes, I think that is potentially very important. Certainly, some of the anecdotes suggest that distance matters in a somewhat field-like way. It is difficult sometimes to separate out psychological factors and physical fields. Some of the anecdotes involve secretaries who say "Don't do any copying whenever Boss X walks into the room because the thing simply won't function at that time," as though physical proximity is needed. When Boss X walks into the room, of course, stress level may go up as well. One other factor is that some apparent field effects may be due to known physical fields. Some computer systems are not properly grounded. If somebody comes in who doesn't like to use the computer and drags his feet across the carpet, he may cause a malfunction in the computer system if it is not properly set up. So there may be some biophysical field interactions with certain kinds of labile components. We think that the distance factor is a very important part of our anecdote collection. We will really want to look at whether or not the key observers need to be physically present or not. Right now the bulk of the evidence suggests that they do. But that is very preliminary.

BENOR: I have noticed on several occasions that tape recorders malfunction. As a psychiatrist I use them in interviews. I also teach and the first sessions with those I am supervising almost invariably have some glitches in them and are certainly high anxiety situations. I was also present at a session where a healer read some of her poetry. People said that it was beautiful poetry and they have tried any number of times to record it, but each time the recording comes out like Mickey Mouse, a very high pitched, very rapid recording. This has been repeated a number of times apparently. It might be of interest to you. I wondered after that as to what part of the system in a tape recorder might be involved. It is pure speculation, but it would seem that the magnetic head would be the most sensitive, as the tape did not seem to speed up, but rather the quality of the recording changed.

MORRIS: Thank you for both of those examples. The first one especially seemed to be the kind of systematic correlation that makes sense and that we would be looking for. It might have an eventual application in terms of enabling you to get yet a further indicator of whether or not someone is unusually tense. As for the mechanism within the tape recorder, I am lost on that. My physics training is rather poor, so for technical expertise, I rely upon computer-run tests and engineers up in Syracuse University. We have thought of buying up old, poorly working equipment, such as tape recorders, and seeing how well people do with them.

WEINER: Two German theorists, von Lucadou and Kornwachs, have looked at the complexity of systems in relation to the observational theories. What they propose is that in any complex system there is a certain amount of indeterminancy or randomness that comes about merely because of the complexity of the system. I am wondering if there is an implication here for computer systems. I am thinking of two questions in particular.

One is at an anecdotal level. Do you see more of the kinds of effects that you are describing in more complex computer systems, in a way that would not be attributable just to the fact that you are dealing with complex software? In other words, do you find that simple programs tend not to show effects of malfunction-linked people, whereas more complex systems do? Secondly, I find it very interesting that in your experiment you are thinking of using five random number generators in combination in order to create various levels of noise. I am wondering if you are seeing the more complex noise systems as being more conducive to this sort of effect than, let us say, a single random number generator?

MORRIS: To answer your first question, we don't particularly see more anecdotes with more complex systems right now. And there may be an artifact, in that some of the larger systems have a lot of additional reliability safeguards built in. Because they are such large systems more care has been put into the training of the people who operate them. They are more likely to be professionals, anyway. We see some anecdotes in the microcomputer area or where there has been poor construction. The component's complexity seems to be very important here. In our study, we had a poor interface board with what seemed to be flaws in more than one location on its surface. So in general I cannot really give you a thorough answer except that these are some of the factors that will have to be taken into account.

Repeat your second question, please.

WEINER: Whether you feel that a more complex type of noise interaction . . .

MORRIS: Oh yes, the five sources of randomness. We wanted to mimic some of the reliability strategies that manufacturers use. One of those is redundancy. In this case we could arrange it so that all our five sources of randomness have to exceed a certain threshold level before a signal is sent, or any of the five must exceed it, or we could vary the sensitivity within each of the five. In other words, we can generate a very rich descriptive situation in order to try to mimic as much as we can what people have been building into machines. Right now we are going to be pretty empirical about it.

GROSSO: I was intrigued, Bob, about the possible applications of this approach to the question of psychic healing. The human body is an obviously very labile system and I just wondered if you had any thoughts on the meaning of all this for the medical field. Also, it strikes me that the implications for military matters are rather frightening. If you think about stress and competition and negative attitudes being key factors that tend to disable machines and computers, the prospect of a nuclear war in which our defense system is based upon this complex system of computers is rather frightening.

MORRIS: It is sad to go from healing to the military, isn't it? As far as that subject is concerned I will reserve some commentary perhaps after Dr. Benor's paper. We have a colleague who has spent a fair amount of time in the Philippines. The analog to the computer there is the bullock and there are the same sets of anecdotes (you know bullocks can crash, too). Some people cannot get along with bullocks and some people get along very well with them. So from the animal as analog to machine, there would seem to be an extension in that direction. Certainly, I agree with your point that organisms can be regarded as labile systems.

SCHOUTEN: I find your ideas very interesting, since I am used to working with malfunctioning equipment myself. I sometimes suspect that, contrary to what physics contends, there is a bit of magic in electronics and it might fit well with what you discussed before. But I must say I have a more practical problem. We know that there is a lot of equipment people work with which will crash now and then or malfunction. I wonder even, if just based on randomness, you can expect that sometimes equipment of certain persons would crash more often. Related to this is the same sort of problem the moment you pursue research. At least in a card guessing experiment we know what the expected distributions are. The trouble with malfunctioning equipment is that I doubt whether we know what the expected distributions are. Not only that, but we also know that factors such as skill are also involved. I think you have a very difficult task ahead to sort this out and to detect a psi effect.

MORRIS: Those reasons are exactly why we have moved towards well understood sources of noise and randomness to be interfaced with the equipment. For a while we were thinking of leading off by buying up bad equipment and then seeing whether or not we found relationships, but for precisely the set of factors that you mentioned we can't even do that. We must move, at least in part, to a system in which we understand the likelihood of a success or a failure rate. We are using sources of noise that have been put through a rather rigorous set of testing protocols. Thus, we understand them well and we can put in the proper controls. Ideally, thanks to the use of modems, it would be our hope to have a source of noise in one location and the equipment operator in quite a distant location, in such a way that it can be the home environment, or an environment that not only resembles the person's workplace, but is the person's workplace. These sources of noise could be interfaced with actual training studies. It is a problem. If we add something and that makes the whole effect go away, then we are back to having to use another strategy and trying to take such factors into account. We do find in the course of trying to sort this out that a lot of the anecdotes we get are very informative about what is not psychic, but looks like it. That includes the gathering of some lore that I don't think is found in the literature yet.

MISHLOVE: Three points. One, to follow up the statement that Michael Grosso made with regard to potential military implications, I did have an opportunity recently to see that same connection made. It was in a recent issue of *Computer World* which reported your work. In the same issue there was a report of a Japanese study conducted with Uri Geller, replicating some work that had been done at Stanford Research Institute many years ago, in which Geller had apparently erased computer tapes. That got the military interested in it at the time. I think that kind of interest is still continuing.

The second thing I would like to mention is an anecdote that you might like to follow up if you are not aware of this work. Back in 1973 an article appeared in the *Journal for the Study of Consciousness.* It was written by Nick Herbert about a device he had designed called the metaphase typewriter, which was a computer system built on the Poisson statistical distribution. Herbert noted that the distribution of letters in the English language was the same as the Poisson distribution. He used a Nova minicomputer to create something like an electronic ouija board. He thought that perhaps psychic influence would cause the computer to create words and sentences. In one of his first experiments he got nothing significant, but there was a malfunction the very first time he operated this system, which was somewhat significant. The printer jammed and it repeated itself three times. It repeated a phrase which spelled out phonetically something to the effect of "And in Infinite Time." So I think you might want to follow up Nick Herbert. He would probably have a lot to add about the concept of "smart noise" that you have introduced there.

The third thing I would like to mention is that I will have a computerized network running similar to the one in Denver that Bill Tedder is using. That is the Parapsychology Information Network. It uses the same software with a random number generator, which will be used for training psi ability in a way similar to that you have described. I will be collecting anecdotal evidence or reports on that system with a hard disk drive. If anything useful comes up, I will share that information with you.

MORRIS: You raised the issue of the military use of psi, Michael. I don't have any answer to this other than to say that it is important that the research be kept public. That way, if there is the possibility of military misuse, more people would have some say in the matter. When I presented a paper at the Parapsychology Foundation's conference on CONCEPTS AND THEORIES OF PARAPSYCHOLOGY, in 1980, I offered a psi liberal and psi conservative model. I suggested that under the psi liberal model perhaps psychic functioning is a bit like the electoral college phenomenon in which some of us ordinarily act like the states of New York and California in fixing a final event and others of us have relatively little contribution; we are like Delaware and Rhode Island. If there is a potential danger perhaps it is important to make sure that enough people know about it so that you have lots of input, or many votes. What you are suggesting is that there may be single individuals who, in certain circumstances, can fix an event exclusively or with very little contribution from those around. In the case of a particular individual such as the one that you mentioned, it is quite possible that, if there was a bona fide anomaly involved, it might have been a contribution of several people, all of whom were starting to monitor unusual events in the environment and get set for them and perhaps even encourage them. We know so little about the dynamics of it.

HEARNE: We all perceive and interpret things according to our personal experiences and outlook. From my own admittedly partial perspective of dream research, I would like to point out something which may or may not be helpful in this discussion.

There are similarities between the behaviors described and typically reported dream events. Malfunctions of equipment at important times are common in the dream world. Dream control can make things work miraculously. These apparent associations may of course be totally spurious, but if there are links then I will predict that other dream-like characteristics, some of which I will talk about tomorrow, may be present in these subjects. The events would tend to occur in roughly a ninety-minute period, corresponding with a continuation into the day of the subject's nocturnal REM cycle. And also the subject's muscular tonus would be low. Conceivably a REM-based PK effect might be operating and although we notice the untoward effects in our artificial modern environment it may originally have been an essentially constructive function. I hesitantly suggest, very speculatively, that it might represent a technique of nature to alter the arrangement of genetic material in the labile stages of cell division in order to increase genetic variation and ultimately aid the survival of the species. If so, these subjects should be able to affect DNA structures. A suitable study could be designed. I would like your comments.

MORRIS: It sounds as though there are some fairly crisp predictions that can be made and looked at and we will try to take them into account. I am very interested in the notion of dream events resembling malfunction-linked and function-linked circumstances; that had not occurred to us before. The closest thing to it has been our interest in the machine as it appears in mythology. I have a friend with whom we are hoping to explore the various changes in the representation of equipment in our modern sources of myth—in movies, in television and so on. At the beginning machinery was not used to save labor as it is primarily now used. It was used for war and for entertainment. It was not until the Dark Ages in the monasteries, that all of the inventiveness that had led to these devices was actually applied to the workplace. Nowadays it is of interest to look at television and notice where you see computers. You see them as instruments of destruction, supercars and military helicopters, or you see them as animated toys and comic relief. It seems as though we may be cycling through this sort of thing again. Relating it to a dream content seems like a very valuable additional way to follow up on this.

PALMER: It seems to me that one of the best ways that we have of getting a handle on the kind of things you are studying is to look at what these anomalous malfunctions correlate with. In fact this might be a way to at last partially get around the kind of problem that Dr. Schouten was mentioning about baselines. I think this will become most useful if models can be developed making so called normal and so-called paranormal assumptions that might predict different patterns of correlations. I was particularly interested in this connection in your point that some of the psychological factors that seem to be correlating with these anomalies are related to the kinds of things that we find in the parapsychological literature generally. But I think what is really crucial is if *conventional* models can be developed. We can then make specific predictions about what kinds of patterns and correlations we are going to find and then see if in fact those kinds of patterns show up or if other kinds of patterns show up.

MORRIS: Yes, I think that this is a very important point. Much of what we are looking for now involves circumstances in which the same kinds of people that we would expect to be malfunction-linked via a psi connection (e.g., people under stress) we would also expect to be malfunction-linked via non-psi connections such as carelessness. And so, of special interest will be circumstances in which they may diverge. Also, much of what we have to do is to see which correlations occur primarily when there is the possibility of a direct non-psi linkage between the person and the equipment and which hold up just as well whenever we essentially have eliminated non-psi linkage.

ROLL: This is one of the wild thoughts you occasionally get that may or may not ever be useful or interesting. Recently I was involved in some PK testing of a gifted subject and we did some studies involving the neuron of a sea slug and she was markedly unsuccessful. I don't know, in fact, if any results have been obtained under those conditions or with this system. On the other hand she was rather successful in PK computer games. And it made me wonder whether perhaps, as part of a protective device, there may be a kind of shielding in the neuronal apparatus against PK. If there is not, it is hard to see how the brain would function. One wonders if it would be possible to think of a device borrowed from a biological system that would protect our computer equipment.

Another issue that has been raised by John and I think perhaps by others relates these effects to known psychological and neurophysiological conditions. I know that some of your studies really don't bear this out, but I am rather impressed by the possibility that the sympathetic nervous system might be active at least in macro-PK and that the parasympathetic system might be ESP conducive. Of course, the parasympathetic and sympathetic nervous systems are active at different times of the day. They are also active in different ways with different people. It would be interesting if one could find diurnal variations in this. Just after a meal when the body is busy digesting food and the sympathetic system is relaxed, would there be less PK than at other times when the person is really ready, on the go and is all active and aroused?

MORRIS: Yes, that is something we can certainly look for. It would be hard to tease out all of the other things that go along with being kind of tired and sleepy after dinner, but once again we could try to look for circumstances in which it makes sense that that would be a mediating vehicle versus ones in which it would not, where there seems to be no connection.

One last comment about the use of the sea slug *Aplesia*, the organism that Ed Kelly's lab is using to generate sources of noise. It is our hope and intention to have his cells drive our computer system via modem over distance and to compare it to another source of noise, such that we are blind as to whether or not the living system is driving our computer. He is varying that in his North Carolina lab and is blind as to the conditions up in Syracuse that we are using.