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Distant Mental Influence of Rate of Hemolysis of Human Red Blood Cells

WILLIAM G. BRAUD[1]

ABSTRACT: A formal investigation was conducted in order to determine whether a relatively large number of unselected subjects would be able to exert a distant mental influence upon the rate of hemolysis of human red blood cells. For each of 32 subjects, red blood cells in 20 tubes were submitted to osmotic stress (hypotonic saline). The subjects attempted to protect the cells in 10 of the tubes using visualization and intention strategies; the remaining 10 tubes served as noninfluence controls. For each tube, rate of hemolysis was measured photometrically over a 1-minute trial period. Subjects and experimenter were "blind" regarding critical aspects of the procedure, and subjects and tubes were located in separate rooms in order to eliminate conventional influences. Results indicated that a significantly greater number of subjects than would be expected on the basis of chance alone showed independently significant differences between their "protect" and "control" tubes ($p = 1.91 \times 10^{-5}$). Overall, blood source (i.e., whether the influenced cells were the subject's own cells or those of another person) did not significantly influence the outcome, although there was a trend toward stronger hitting in the "own blood" condition. Additional analyses of the results were performed by SRI International researchers to determine whether the data were better described by remote action (causal) or by intuitive data sorting (informational) predictions; the results of those mathematical analyses were inconclusive. This research is presented in the context of methodologies for investigating a possible role of psi in self-healing.

Laboratory research has indicated that under certain conditions persons are able to psychokinetically influence a variety of biological systems (see

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Solfvin, 1984). At the Mind Science Foundation (MSF), we have been able to observe successful distant mental influences upon the spatial orientation of fish, the locomotor activity of small rodents, and the physiological activity of another person (Braud, 1978a, 1979; Braud, Davis, & Wood, 1979; Braud & Schlitz, 1983; Schlitz & Braud, 1985). Such findings are consistent with an interpretation of psychic healing in which the healing might be contributed, at least in part, by the healer's conscious or unconscious psychokinetic influence upon the healee's bodily processes.

It is a relatively straightforward matter to design experiments to isolate a possible psi component in one person's healing of another. The healee may be kept blind regarding the timing and nature of a healing attempt, and various isolation and control procedures can be applied. However, it is ordinarily impossible to study the role of psychic functioning in *self*-healing *in vivo* using such techniques. The healer is necessarily aware of the timing and nature of self-healing attempts, and therefore the psychic process cannot be isolated from the many nonpsychic factors that can influence healing. We cannot distinguish a psychic effect from the more conventional influences of expectation (the "placebo" effect), changes in emotionality, self-regulation of neural, muscular, and hormonal activities, etc. Fortunately, it may be possible to eliminate the influence of these nonpsychic processes through the use of biological psychokinesis (bio-PK) protocols that have proved useful in the study of distant mental influence. The strategy would involve the selection of some specific biological activity to be targeted psychokinetically and then the *removal* of the measured biological activity, in space or in time, from the reach of all possible nonpsychic self-influences.

Spatial or temporal isolation could be accomplished in three ways:

1. The experimental participant could attempt to influence cells, tissue, or biochemicals that have been freshly *removed* from his or her body.

2. The participant could attempt to influence his or her own biological activity that had been *prerecorded* at an earlier time and that had remained unobserved until the subsequent influence attempt; this strategy involves the so-called "time-displaced" or "retro-psychokinesis" design explored by Schmidt (1976, 1981; Schmidt, Morris, & Rudolph, 1986). Another method of removing the target biological activity in time would be to ask participants to attempt to influence their own *future* activity. In this case, the influence epochs would have to be coded in a way that would eliminate the possibility that the participant might remember the desired outcome and consciously or unconsciously self-regulate at the time of the future test in order to bring about the desired changes.

3. The participant could attempt to influence a particular physiological or biochemical process within his or her body while, at the same time, the activity of a similar, externalized process is monitored to determine whether the latter responds in "resonance" or in "sympathy" with the former.

If research participants succeed in influencing their biological materials through psychic means when those materials are isolated, then it is likely that the biological materials remain susceptible to psi influence under ordinary, nonisolated conditions as well. Psi influence thus becomes a viable component in self-regulation and hence in self-healing. We might even find that persons are psychically able to influence their own cells or activities more readily than they are able to influence the cells or activities of another person. If this is indeed the case, it would suggest that psi's contribution to self-healing may be greater than its contribution to the healing of another person. It would also suggest that more impressive results might be obtained in bio-PK studies if experimenters selected target systems that were more closely associated with the participant-influencers in their experiments.

We have conducted numerous bio-PK experiments in which both selected and unselected participants were able to alter significantly the activity of specific biological target systems, mentally and at a distance. In all of those studies, the amount of target system activity in the prescribed direction during a number of influence periods was compared statistically with its activity during an equal number of interspersed control (noninfluence) periods. The obtained bio-PK results have been reliable and relatively robust. For example, a recent review of all of the MSF's electrodermal bio-PK experiments conducted to date indicated a $z = 4.08$, $p = .000023$, and mean effect size = 0.29 for all 13 experiments combined (Braud & Schlitz, 1989). Experiments could be conducted, using an identical methodology, in which persons attempt to influence their *own* biological materials.

If Eccles (1977) and others are correct in maintaining that one's mind routinely exerts a true psychokinetic influence upon one's own brain through "cognitive caresses" of the synapses of cortical neurons, then perhaps the most ideal target material would be nervous tissue that had been removed and cultured externally (or cloned). At first, it might appear that such an experiment would not be feasible. However, a study of this type could actually be done with the cooperation of a neurosurgeon. Brain tissue that is removed for medical reasons and that is ordinarily discarded might be artificially cultured and maintained as target material for bio-PK attempts by the patient, following his or her recovery from the operation.

Outside of this seemingly science-fictional scenario, the next best target material might be lymphocytes (white blood cells with important roles in the immune process: B-cells, T cells, natural killer cells). Unfortunately, the procedures required for the measurement of these cells or of their biological activities are relatively complex and beyond the capabilities of most psi research facilities. It is noteworthy that several researchers recently have reported results of experiments in which their subjects were strikingly successful in self-regulating specific sub-populations of their leukocytes (e.g., neutrophils) using relaxation and imagery techniques (see Braud, 1986; Hall, 1984a, 1984b; Schneider, Smith, & Whitcher,

1984). The work of Schneider et al. is especially interesting in view of the *accuracy, rapidity,* and *specificity* of the influences that occurred without the provision of conventional sensory feedback. The process appears goal-directed and immediately reminds one of the similar goal-directed nature of psychokinesis.

The third best, and logistically the easiest, material with which to work would be osmotically stressed red blood cells. The goal of the experiment would be to protect one's own red blood cells and retard their rate of hemolysis. If red blood cells are maintained in fluids having a salinity similar to that of the blood plasma, the cells survive for long periods. However, if placed in a fluid having a salinity lower than that of the plasma (e.g., in distilled water or in very dilute saline), the corpuscles swell due to the movement of water through their semipermeable membranes. Eventually the cells rupture and release their hemoglobin content into the surrounding medium. The rate of hemolysis can be measured using a spectrophotometer with an output to a computer and pen recorder. Light of a given wavelength is passed through a tube of blood cells suspended in dilute saline. Intact cells are relatively opaque to the light. As the cells rupture, the solution becomes increasingly transparent. The spectrophotometer/computer/pen recorder system provides an objective readout of the change in light passage over time, and hence the time course of hemolysis. Rate of hemolysis can be measured during influence trials in which the research participant attempts to mentally retard the hemolytic process, that is, attempts to psychokinetically protect the red blood cells from osmotic injury. These results can be compared with hemolysis rates obtained during interspersed control trials in which no psychokinetic attempts are made.

We conducted a preliminary experiment of this sort in our laboratory several years ago. In that experiment, involving a single selected subject and a small number of trials, a significant influence of hemolysis rate was observed (Braud, Davis, & Wood, 1979). In the present experiment, we sought to repeat that experiment with many more trials, a large number of unselected subjects, and an improved methodology, in order to test the reproducibility and generality of the finding. Briefly, subjects attempted mentally to retard the rate of hemolysis of osmotically stressed human red blood cells that were isolated from all conventional influences. The subjects and the target system were kept in separate rooms. Rate of hemolysis was monitored accurately by a spectrophotometer interfaced by means of an analog-to-digital converter to a microcomputer. The experimenter operating the equipment was blind regarding the scheduling of the influence (protect) versus noninfluence (control) attempts. Half of the subjects worked with their own blood cells, and half worked with cells from another person; both experimenter and subject were blind regarding the blood source. The experimental design included features that we hoped would help us determine whether any obtained psi effect might be most parsimoniously interpreted as a true psychokinetic (remote action) effect or, alternatively, as an instance of "intuitive data sorting" (see May,

Radin, Hubbard, Humphrey, & Utts, 1985). Prior to the formal experiment to be described in detail in this paper, two additional studies were conducted—a pilot study and an "intermediate phase" study. Space limitations permit only relatively brief summaries of those two studies.

Summary of the Pilot Phase

Thirty-two unselected subjects participated in a pilot study designed to explore the new methodology and to determine whether blood source (own blood cells vs. another person's blood cells) was an important factor. An experimental session involved hemolysis measurements for 10 blood tubes. The subject attempted to retard the rate of hemolysis of 5 of these tubes, mentally and at a distance. The remaining 5 tubes served as control tubes that the subject did not attempt to influence. The 5 influence and 5 control tubes were scheduled according to a random sequence that was prepared by a third party and that was unknown to the experimenter who made the hemolysis measurements. Light transmission through each tube (which is proportional to hemolysis) was measured for each second of a 2-minute sampling period; the difference between the mean of the initial 5 seconds and the final 5 seconds of light measurements yielded a change score that served as the hemolysis measure.

Following the completion of the experimental session, 10 additional blood-containing tubes were measured for hemolysis rate. It was intended that these 10 measurements would provide additional "nonlocal" baseline data and would also be useful in comparing remote action (RA) versus intuitive data sorting (IDS) predictions of the experimental outcome. According to the RA hypothesis, the mean of the 5 "local" control tubes should be equivalent to the mean of the 10 nonlocal baseline tubes, and the mean of the 5 influence tubes should be lower (i.e., in the direction of less hemolysis or greater protection of the cells) than both of the former means. According to the IDS hypothesis, the mean of the local controls should be above, and that of the influence tubes should be below, that of the nonlocal baseline tubes; the *grand mean* of the *10* tubes for the experimental session should not differ from the mean of the 10 nonlocal baseline tubes.

An analysis of variance of the hemolysis scores indicated extremely great and highly significant variability among the subjects, but no other significant main effects or interactions. Therefore, significant evidence for a remote influence of the blood cells was not obtained in the pilot study. There was, however, a nonsignificant tendency for a slight "protection" effect in the "another's blood" condition, whereas the opposite effect (i.e., *less* protection during the influence trials) occurred in the "own blood" condition. The nonlocal baseline measurements were found to be inadequate for their intended purpose because in every case but one the mean percent light transmittance change score for the 10 nonlocal baseline

tubes was lower than both experimental sessions means (i.e., consistently lower than both the control and the influence tube means). It was determined that this consistent reduction in hemolysis for the nonlocal baseline tubes (and to a lesser extent, for the tubes later in the experimental sessions as well) was due to a progressive change in the blood cells contributed by several environmental factors that increased the "noise" level of the experiments and that included higher apparatus (i.e., spectrophotometer tube holder) temperatures during later tests, and increasing exposure of the blood cells to temperature changes, air, and mechanical trauma (i.e., mechanical agitation) during the course of repeated tests of a single blood sample (i.e., multiple tests of the contents of a single Vacutainer blood collection tube). As a result of the pilot sessions themselves, as well as additional tests conducted concurrently with and subsequent to the pilot experiment, the sources of these interfering factors were identified, and steps were devised that could be taken to eliminate or greatly reduce them in the formal study.

Temperature changes in the spectrophotometer tube holder were controlled through (a) the addition of an external cooling fan to the apparatus, (b) reducing the durations of the hemolysis measurement periods, and (c) turning off the apparatus except when measurements were actually being made. The substitution of a more effective anticoagulant (acid-citrate-dextrose) for that used in the pilot study (heparin) greatly diminished the effects of progressive exposure to room temperature, air, and mechanical trauma during repeated pipette samplings so that hemolysis rate remained relatively stable over the course of 20 measurements from a given main Vacutainer source tube. When between 20 and 30 samples had been taken from a main Vacutainer tube, this stability began to deteriorate.

Summary of the Intermediate Phase of Salinity Tests

Following the completion of the pilot study, salinity tests were conducted in order to determine salinity values that might mimic anticipated psi-induced hemolysis rate changes. These tests provided the basis for Monte Carlo analyses that were designed to determine appropriate parameters for an adequate differential test of the IDS versus RA predictions of psi functioning that was to be conducted in the formal study.

A total of 332 hemolysis trials were completed using whole blood samples collected from 10 different persons. For these tests, the "noise-reducing" improvements mentioned above were incorporated. Hypotonic salinity values of 0.425%, 0.429%, 0.434%, 0.442%, and 0.450% (corresponding, respectively, to 50%, 50.5%, 51%, 52%, and 53.33% of 0.85% normal physiological saline) were tested. Sampling epochs of 1-minute duration were used, rather than the 2-minute periods of the pilot study. All other procedures were identical to those of the pilot study. These were all,

of course, "control" tests in which no subjects attempted to influence the hemolysis process.

As anticipated, the "noise-reducing" improvements resulted in the virtual elimination of the extreme variability seen in the pilot study and yielded much greater stability (less degradation) of the blood samples. The optimum salinity value for mimicking an anticipated psi-induced reduction of hemolysis rate of approximately 1.0 standard deviation was found to be in the vicinity of 0.429%–0.434% saline (equivalent to 50.5%–51.0% of normal 0.85% physiological saline). Monte Carlo simulation analyses conducted on these salinity data indicated that on the basis of the magnitudes of hemolysis changes observed in these intermediate phase salinity tests, the use of 2 versus 8 samples (tubes) distributed throughout equivalent "psi effort" periods would provide adequate measurements for a differential test of the IDS versus RA interpretations of any psi effects obtained in the formal experiment.

Another purpose of these salinity tests was to assure that our spectrophotometric method was actually assessing hemolysis, rather than other possible artifactual time-changing processes that could be confused with hemolysis. A number of tests were performed using identical procedures but with normal 0.85% physiological saline rather than hypotonic saline. No hemolysis should occur with such a solution, and any changes observed could be attributed to artifacts. As expected, hemolysis did not occur in these normal saline tests; the photometric readings and curves were completely stable throughout the sampling periods.

Overview of the Formal Experiment

On the basis of the findings of the preliminary study, the pilot study, and the intermediate phase experiments, a final protocol for the formal experiment was developed that included the following features:

1. Thirty-two subjects (from the same population and selected in the same manner as in the pilot study) would each participate in one experimental session. Hemolysis measurements would be made by the experimenter, W.G.B.
2. Sixteen subjects would attempt to influence (protect) their own blood cells, and 16 would attempt to influence the cells of another person. Both subject and experimenter would be blind regarding the source of the blood until all 32 sessions had been completed. This "own" versus "other" factor was retained in the formal experiment because of the trend toward different outcomes in those two conditions observed in the pilot study.
3. Blood samples would be collected in Vacutainer tubes containing acid-citrate-dextrose (ACD) anticoagulant and would be refrigerated immediately after the blood was drawn. Blood samples would be stored at

4°C and would be removed from the refrigerator only briefly, before each hemolysis trial.

4. Hemolysis trials would be conducted between 14 and 42 hours following a blood draw. The ACD anticoagulant permits cold storage of blood cells for as long as 3 to 4 weeks with minimal deterioration of red blood cells.

5. The temperature increase of the spectrophotometer would be minimized by means of an external cooling fan, the use of shorter sampling epochs, and allowing the apparatus to remain on only during hemolysis measurement periods.

6. A session would consist of four 15-minute periods—two control (C) periods and two protect (P) periods. For half of the subjects, these periods would be scheduled in a CPPC order; for half of the subjects, a PCCP order would be used. This block-counterbalancing design was employed in order to assure that any reasonably linear potential progressive error (such as changes in hemolysis rate due to slight progressive warming of the apparatus) would contribute equally to the two (C and P) conditions and therefore not introduce a systematic bias. Whether a given subject's sequence was CPPC or PCCP would be randomly determined by an associate (M.S.) through use of the RAND table of random numbers. The experimenter doing the hemolysis measurements would, of course, be blind regarding these sequences. A subject would learn his or her proper sequence by consulting a sealed envelope delivered to the subject after the experimenter's interactions with the subject had been completed and the experimenter had returned to the equipment room.

7. The beginning of each 15-minute period would be signaled by an appropriate number of tones delivered to the subject's headphones. The subject would have been instructed to attempt to mentally *decrease* the rate of hemolysis of the distant red blood cells during the two 15-minute protect periods. During the two 15-minute control periods, the subject would attempt not to think about the experiment and would allow the cells to hemolyze at their normal, rapid rate. During the two protect periods, the subject would view a projected color slide of healthy, intact red blood cells as an aid to visualization and intention. During the two control periods, the subject would close his or her eyes and think about matters unconnected with the experiment.

8. During each 15-minute period, either two or eight hemolysis tubes (samples) would be measured. Monte Carlo analyses conducted at SRI International indicated that curves derived from 2 versus 8 tubes (samples) would be sufficient for an adequate test of the IDS versus RA interpretations of any obtained psi effect. The subject would be blind regarding the number of tubes being measured during any 15-minute period and would be instructed to apply mental effort as steadily and as consistently as possible throughout the entire 15-minute protect periods. The experimenter would learn whether to measure 2 or 8 hemolysis tubes during each 15-minute period by consulting a sealed envelope delivered to him just before

the beginning of the measurement session. This random, balanced tube sequence would have been determined earlier by M.S., again using the RAND table of random numbers.

9. Because the subjects must remain blind regarding the number of tubes being measured during each 15-minute period, it would not be possible to provide them with real-time auditory feedback of the progress of hemolysis, as we had hoped to do. Such feedback would provide subjects with information about the number of tubes and would therefore violate the blindness requirement and add a psychological confound to the experiment. However, the subject would receive numerical feedback about hemolysis outcomes at the conclusion of the session.

10. The subject's session would be preceded by 8 minutes of tape-recorded instructions for relaxation and guided imagery, designed to help reduce distractions and focus attention upon the desired goal event—viz., decreased hemolysis during effort (protect) periods.

11. Hemolysis measurements would be accomplished with a procedure identical to that used in the pilot study, with the following exceptions: (a) the recording epochs would be 1 minute rather than 2 minutes in duration, and (b) the subject would not hear tones signaling the beginning and end of each *tube* measurement (as in the pilot study), but rather would hear tones signaling the beginning of each of the four 15-minute periods.

12. Hemolysis scores would be analyzed in a manner identical to that described in the pilot study. A similar ANOVA would be used to assess the presence of a psi effect. In addition, all hemolysis percent change scores would be normalized for purposes of additional IDS versus RA analyses.

METHOD

Subjects

Thirty-two subjects participated in the study. Participants were selected from a pool of normal, healthy individuals and were screened to eliminate those with known allergic or immunological disorders or other illnesses and those currently taking medication (other than oral contraceptives and/or occasional cold medicines). Twenty-one of the subjects had already participated in the pilot investigation and were asked to participate again because of their familiarity with the procedure. Eleven subjects were first-time participants who substituted for pilot study subjects who were unable to take part in the formal study. The final sample consisted of 17 females and 15 males, ranging in age from 23 to 53 years. Each subject was paid $20 as a token of appreciation for the inconvenience and slight discomfort of donating a blood sample and for participating in the subsequent 1½-hour laboratory session.

Procedure

On a Monday evening, the experimenter met with a group of four participants in order to explain the experiment in detail and to have the subjects complete an Informed Consent Form, donate a 10 ml venous blood sample, and schedule an appointment for an experimental session for later that same week (i.e., on either the next day [Tuesday] or the day after [Wednesday]). An attempt was made to schedule two experimental sessions on Tuesday (at 10:00 a.m. and at 2:00 p.m.) and two sessions on Wednesday (at 10:00 a.m. and at 2:00 p.m.). On the Monday evening, the participant was given a two-page written description of the procedure and was asked to read the description at home and become familiar with it.

The four blood samples were drawn by a registered nurse.[2] The blood collection tubes (Becton Dickinson Vacutainer tubes containing acid-citrate-dextrose anticoagulant) were labeled with the names of the blood donors and were placed in a small refrigerator immediately after the blood draws. The refrigerator was maintained at 4° C throughout the experiment. When all four blood samples had been drawn, the nurse switched the name labels on two of the tubes, using a randomizing schedule that had been prepared ahead of time by an associate of the experimenter (M.S.). This schedule was always kept by the nurse (and a copy kept by M.S.) and was unknown to the experimenter until the study had been completed. The purpose of switching the labels of two tubes was to permit two subjects to attempt to influence their own blood and two to attempt to influence another person's blood that week, and to keep the subjects and the experimenter blind regarding the blood source until all 32 sessions of the study had been completed.[3]

Following his or her arrival for the experimental session on Tuesday or Wednesday, the experimenter showed the subject the equipment at the target site, emphasized the spectrophotometer tube holder in which the target tubes later would be placed sequentially, and then escorted the subject to the distant subject room, located in another part of the building (see floor plan in the Figure). The subject sat in a comfortable armchair and was told that shortly after the experimenter left the subject's room, an assistant would slip an envelope under the subject's door. The subject was

[2] The order in which the subjects' blood was drawn, and hence their subject numbers for the blood source factor (i.e., whether they subsequently attempted to influence their own or another person's blood) was determined by the alphabetical sequence of the surnames of the four subjects who assembled on any given Monday evening blood-drawing session.

[3] On one Monday evening, a last-minute cancellation by a subject resulted in three, rather than the usual four, blood draws that evening. The next week, the subject who had cancelled for the previous week appeared; there also appeared an additional subject who was not expected, resulting in six subjects that evening. For the two subjects who did not conform to the schedule that evening, blood tubes were inadvertently switched, when they should not have been. This resulted in a total of 18 subjects in the "another's blood" condition and 14 subjects in the "own blood" condition.

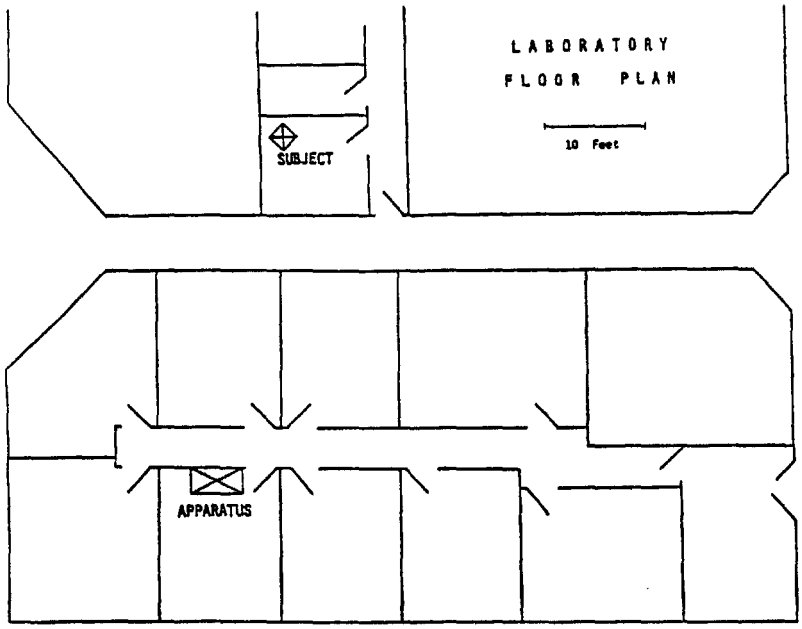

Fig. Floor plan of the laboratory rooms in which the experiments were conducted. The apparatus room and the subject room are situated in separate suites of the same building, with an exterior corridor separating the two suite areas. Interior corridors separate the rooms within each suite area. The subject room is windowless. The windows of the apparatus room were completely occluded during experimental trials.

to retrieve that envelope and open it to find the random sequence of the four 15-minute periods of the experiment. (The 32 period-sequence envelopes had been prepared beforehand by M.S. using the RAND table of random numbers and a private algorithm. Throughout the experiment, the envelopes remained hidden from the experimenter. M.S. retained a copy of the period sequences for the 32 envelopes.) During each of the two 15-minute control periods, the subject was to attempt to keep her or his mind off of the experiment and to think of other matters; if she or he could not help thinking about the experiment, the subject was asked to imagine hemolysis proceeding at its normal, rapid rate. During each of two 15-minute protect periods, the subject was to attempt to mentally retard the rate of hemolysis of the red blood cells in the tubes for that period using any of the mental strategies described on the instruction sheet. The experimenter demonstrated a slide projector that could be used by the subject during the two protect periods. The 35 mm color slide depicted healthy, intact red blood cells, and it was included as a helpful aid to the subject's visualization of the desired goal. The subject was told that the beginning of each period would be signaled by an appropriate number of tones (one for Period 1, two for Period 2, and so on) presented through headphones.

The subject was also told that the first period would be preceded by an 8-minute progressive relaxation and guided imagery exercise designed to help the subject reduce distractions and focus attention upon the desired goal event, that is, decreased hemolysis during the protect periods. The exercise was accompanied by low-volume, ambient music and ocean sounds. Low-volume ambient music was also presented through the subject's headphones throughout the four periods of the experiment and was interrupted only for the four-period signaling tone presentations. The conclusion of the experiment was indicated to the subject by the cessation of the music. At that time, the subject was to sign and date his or her period sequence sheet and then be escorted back to the apparatus room by an assistant.

The experimenter returned to the apparatus room, where the equipment had already been readied for use. Just before entering this room and closing the door, he indicated to an assistant that the experiment was about to begin. The assistant gave him a sealed envelope that contained information about his 2- versus 8-tube sequence for that session, and then delivered another sealed envelope to the subject; this latter envelope contained the subject's protect versus control period sequence for that session. The experimenter started the audiotape that presented the preliminary exercises to the subject. He then conducted the 20 hemolysis measurements for the session. From his point of view, there were also four 15-minute periods of measurements; two of the periods (indicated on a sheet within his envelope) were to involve measurements of two tubes, and two of the periods were to involve measurements of eight tubes. This number of measurements factor was included to provide data for a differential test of the IDS and RA predictions of psi performance (see below). The subjects remained blind regarding the tube number schedule for the session.

Each of 20 identical 10-ml glass spectroscope tubes had been filled beforehand with 6.0 ml of 0.425% saline, and these had been kept in the refrigerator at 4° C. The saline for all tubes for all sessions came from the same stock solution of 0.85% normal physiological saline, purchased in 20-liter quantity from Fisher Scientific Supply Company and diluted with distilled water to 0.425% by the experimenter before the study began. This use of solution from the same stock eliminated variability that otherwise might have been contributed by that factor. The experimenter removed the main blood collection (Vacutainer) tube bearing that subject's name from the refrigerator, inverted the tube eight times in order to assure a homogeneous suspension of its blood cells, opened the tube, and placed it in a test tube rack on the equipment table. He then removed the first of the hypotonic saline tubes from the refrigerator and allowed it to stand at room temperature and warm slightly so that moisture from the warmer room-temperature air no longer condensed on the tube after the latter was wiped with tissue. He placed the now frost-free saline tube into the holder of the spectrophotometer and adjusted the controls of the device so that a digital reading of precisely 100.0% light transmission was obtained for

this blank tube. He pressed a computer keyboard key to initiate a subroutine that signaled the subject in the distant room that a 15-minute period was about to begin. He next removed the tube from the holder and added to the tube 100 μl of whole blood from the main Vacutainer tube. He quickly stoppered the saline tube with a rubber stopper, inverted the tube twice to assure homogeneity of its contents, and quickly replaced the tube in the spectrophotometer holder. When the holder cover was closed, the chart recorder pen moved to indicate minimal light transmittance; at the point of greatest excursion of the pen, the experimenter pressed a keyboard key to initiate the 1-minute sampling epoch for that tube. The Vacutainer blood collection tube was then returned to the refrigerator, and the next hypotonic saline tube was placed in the test tube holder so that it might warm slightly for the next trial. The precise timing of all procedural events was controlled by the experimenter through the use of several procedural cues and by means of extreme stereotypy of responding. Throughout the sampling epoch, the chart recorder and the digital readout of the spectrophotometer were shielded so that they could not be observed by the experimenter. This was done in order to eliminate immediate feedback to the experimenter in the hope that this might reduce the latter's own psi contribution to the experimental outcome.

Percent light transmittance measures at a wavelength of 660 mμ (an absorbance minimum for hemoglobin) relative to the blank tube containing saline alone were taken by means of a Sequoia-Turner Model 390 spectrophotometer with digital and chart recorder readouts. The spectrophotometer provided an analog output that varied from 0 to 1.0 v DC and was linearly related to percent light transmittance (with 0 v DC = 0% T and 1.0 v DC = 100% T). This output was increased by a factor of 10 by means of a differential amplifier, and the resulting 0 to 10.0 v DC signal was fed into an analog-to-digital converter installed in an IBM PC-XT compatible computer. The A/D converter (CGRS Microtech PC DIADAC 1) uses an industry standard AD 574A 12-bit A/D chip with 0.0024 volt accuracy and 35 μsec conversion speed. A software program was written that sampled the A/D converter at the end of each second of the 1-minute trial period. Thus, the system automatically provided 60 measurements of the time course of hemolysis (i.e., percent transmittance) during each 1-minute trial. The 60 values were written to a floppy disk file and were also printed out at the end of the trial. In addition to this digital data collection, an analog chart record was obtained for each trial (using a Markson Model 1202 pen recorder).

At the end of the 1-minute sampling epoch, the experimenter removed the tube from the holder and began his preparations for the remainder of the trials. Approximately one minute elapsed between trials. If a period called for the measurement of two tubes, those two tubes were measured at the middle of the 15-minute period, that is, at times corresponding to the measurement of tubes 4 and 5 of an eight-tube period. The main Vacutainer blood collection tube and the hypotonic saline tubes remained in

the refrigerator except when needed for the measurements. The completion of the hemolysis measurements for the 20 tubes of an experimental session required one hour.

When the 20th and final tube had been measured, and the results had been printed, the experimenter notified his assistant that the session was over. While the assistant went to the subject's room, the experimenter made photocopies of the data sheets and of his tube-number schedule. When the assistant returned with the subject, the assistant photocopied the subject's control/protect period sequence sheet. The assistant and the experimenter then exchanged copies of their respective sequence sheets and data printouts. These duplicate records were filed for safekeeping by the assistant and by the experimenter.

The experimenter and the subject then went to the experimenter's office, and the subject described the techniques used to attempt to influence the blood cells. After this interview, the experimenter calculated the results for the experimental session and provided the subject with information about the session outcome. This information consisted of verbal and numerical feedback about the hemolysis rates for the 20 tubes. The experimenter thanked the subject for his or her participation, and the subject left the laboratory.

Results

When all 32 experimental sessions had been completed, the blood source information was decoded so that a determination could be made of which subjects attempted to influence their own blood and which attempted to influence blood from another person. For each session, *change scores* were calculated for each of the 20 blood sample tubes (trials). For each tube (trial), the mean of the initial five A/D converter values was subtracted from the mean of the final five A/D converter values. This change score represented the change in percent light transmittance from the first 5 seconds to the last 5 seconds of the 1-minute trial and provided a quantitative measure of the rate of hemolysis for a specific blood sample tube. For each subject, change scores were available for 10 control tubes and 10 influence (protect) tubes; for each tube condition, scores were available for either 2- or 8-tube measurements during each 15-minute period. Using these change scores, a three-factor analysis of variance was used to test the major hypotheses of the study. In this ANOVA, the three factors were: blood Source (own vs. another's, between); Subjects, random and nested under Source; and Condition (protect vs. control, within). The three experimental questions explored in this formal study were the following:

1. Would the rate of hemolysis (change scores) for the protect tubes differ from that for the control tubes? Such an effect would be indicated, in the absence of a significant Condition × Subjects interaction, by a

significant Condition main effect in the ANOVA. Should the Condition × Subjects interaction effect prove significant, the condition effect would be examined separately in each of the individual subjects, using appropriate within-subject error estimates.

2. Would the degree of influence of hemolysis rate differ for the two blood sources (own cells vs. another's cells)? Such an effect would be indicated by a significant *interaction* of the Source and Condition factors of the ANOVA.

3. Would results for the two-tube measuring periods differ from those for the eight-tube measuring periods, and would the function describing this two- versus eight-tube effect match more closely the RA or the IDS prediction?

For the statistical tests, any probability value found to be less than or equal to .05 would be deemed significant.

The summary table for the ANOVA is given in Table 1, and means and standard deviations for the various groups and conditions are given in Table 2. The main effects for Condition and Source did not reach significance, nor did the Source × Condition interaction. However, the main effect for Subjects and the Condition × Subjects interaction were highly significant. The former effect, of course, indicates significant variability in outcome among the 32 subjects of the experiment. The significant Condition × Subjects interaction indicates that the effect of Condition (protect vs. control) differed from subject to subject; therefore, an interpretation of the Condition main effect was inappropriate, and individual subject by subject condition comparisons were called for.

These individual comparisons were made by means of matched t tests, computed for each of the 32 subjects. These were calculated by comparing the hemolysis (change) scores for a subject's 10 protect tubes with the scores for his or her 10 control tubes. Individual t tests were calculated using separate estimates of variance, instead of using the combined estimate of error variance from the ANOVA, because of the wide spread among the variances across subjects. The t scores for the individual subjects are presented in Table 3. The independently significant subjects (i.e., those with $|t|\ [18] > 2.101$, $p < .05$, two-tailed) are indicated by as-

Table 1
ANALYSIS OF VARIANCE SUMMARY TABLE

Source	*df*	SS	MS	*F*	*p*
Source (own vs another's)	1	0.3480	0.3480	0.001	.981
Condition (protect vs control)	1	2.2278	2.2278	0.461	.503
Subjects	30	18078.7369	602.6247	297.626	$<10^{-16}$
Source × Condition	1	2.6061	2.6061	0.539	.469
Condition × Subjects	30	145.1072	4.8369	2.389	.000063
Error	576	1166.2668	2.0248		

Table 2
MEANS AND STANDARD DEVIATIONS FOR THE PERCENT CHANGE SCORES FOR THE VARIOUS CONDITIONS

Blood Source	Control	Protect	Overall Mean
Own	$\bar{X}$ = 43.63	$\bar{X}$ = 43.36	$\bar{X}$ = 43.50
	SD = 5.07	*SD* = 5.10	*SD* = 5.08
Another's	$\bar{X}$ = 43.45	$\bar{X}$ = 43.45	$\bar{X}$ = 43.45
	SD = 5.94	*SD* = 5.73	*SD* = 5.83
Average %	$\bar{X}$ = 43.53	$\bar{X}$ = 43.41	$\bar{X}$ = 43.47
Own/Another's	*SD* = 5.57	*SD* = 5.46	*SD* = 5.51

terisks.[4] The condition effect was significant in 9 of the 32 subjects. This is to be compared with the 1.6 significant scorers expected on the basis of chance alone. The probability of observing 9 or more independently significant scorers among 32 subjects is 1.91×10^{-5} (exact binomial test).

In seven of those subjects, scoring was in the direction of psi hitting (i.e., slower hemolysis in the protect than in the control tubes); in two subjects, scoring was in the direction of psi missing (i.e., faster hemolysis in the protect than in the control tubes). In order to determine whether these nine independently significant subjects show a general tendency to-

Table 3
SCORING RATES (*t* TESTS) FOR INDIVIDUAL SUBJECTS

Subject	*t*	Subject	*t*
1	−2.17*	17	1.24
2	1.47	18	−0.98
3•	0.31	19•	2.14*
4•	−1.26	20•	−0.68
5•	−0.51	21•	−1.04
6	1.28	22	−1.14
7	0.39	23•	3.39*
8	−1.15	24	0.26
9	−0.51	25•	3.04*
10•	−0.25	26•	1.96
11	−0.84	27	−1.46
12•	2.52*	28	−0.70
13	2.96*	29	3.08*
14	0.17	30•	2.53*
15	−2.79*	31•	−1.24
16•	−1.52	32	1.10

* Independently significant ($p < .05$)
• Indicates "own blood" condition

[4] In order to identify significant scorers, a two-tailed test was used, allowing for the possibility of significant psi missing. This was done because the pilot study had yielded a considerable number of scores in the missing direction. If one wishes to predict only psi *hitting*, a critical $t = 1.73$ ($p < .05$, one-tailed) could be used. By such a hitting-alone criterion, eight independently significant hitters may be identified (Subject No. 26 now reaches significance). The probability of observing 8 out of 32 independently significant hitters is 1.39×10^{-4}.

ward *hitting,* a single-mean t test may be calculated for the nine t values, comparing them with MCE = 0; such a test yields evidence for significant hitting ($\bar{X}$ = 1.63, SD = 2.23, t [8] = 2.07, p = .035, one-tailed).

In the overall (ANOVA) analysis, no effect was found for the Source variable: Scores for the "own" and "another's" groups were virtually identical. The Source × Condition effect, which would have indicated a dependence of the protect versus control effect upon the source of the blood, was clearly nonsignificant. Therefore, we must conclude that blood source was not an important variable in this investigation. However, an interesting trend emerges when we examine the blood source for the nine independently significant subjects. For this subgroup (for which there was evidence for a psi effect), a comparison of the t scores of the five subjects who influenced their own blood with those of the four subjects who influenced another person's blood yields a trend of greater positive scoring (i.e., psi hitting) for the "own blood" subjects (see Table 4). Because of the small number of subjects involved in the comparison, this trend is not significant (t [7] = 1.73, p = .12, two-tailed). The large magnitude of the difference, however, suggests that blood source would be an interesting variable to explore in future studies of this type.

An anonymous referee of this paper described the results of a post hoc analysis that he or she performed on the "own" versus "other" scores; that analysis pointed to a possible true scoring pattern for the two blood source conditions. The referee reported that for the 14 subjects who worked with their own blood cells, a 2 × 2 table can be constructed that divides them by positive versus negative change score × significant versus nonsignificant change. Of the 7 with positive change, 5 were significant; of the other 7, none were significant ($p < .02$). The corresponding table for the 18 subjects working with someone else's blood cells yields nonsignificant differences for these same classifications.

The raw data collected in this experiment were sent to researchers at SRI International so that they might perform certain mathematical analyses of the scores to determine which of two models of psi, the RA model or the IDS model, would provide better predictions of the obtained results for the 2-tube versus 8-tube conditions. Space limitations do not

Table 4
COMPARISON OF OWN VS. ANOTHER'S t SCORES FOR INDEPENDENTLY SIGNIFICANT SUBJECTS

Own	Another's
2.52	−2.17
2.14	2.96
3.39	−2.79
3.04	3.08
2.53	
$\bar{X}$ = 2.72	$\bar{X}$ = 0.27
SD = 0.44	SD = 2.76

permit a detailed description of the rationale, nature, or specific results of those analyses. However, the gist of their conclusion was that the extreme heterogeneity of the data made it impossible to make an adequate determination of which model provided a better fit of the obtained scores. They argued that psychic functioning, whatever its underlying mechanism, is highly individualized, making it difficult to test a specific theory using data combined across subjects; in the present experiment, insufficient data were collected for any one subject to allow tests of RA versus IDS predictions *within* individuals. Additional details regarding the IDS/RA analyses may be found in an SRI International technical report (Hubbard, Utts, & Braud, 1987).

We conducted our own analyses of the tube number factor simply by comparing the differences between the mean change scores for the control and the protect periods for the 2-tube condition with the corresponding differences for the 8-tube condition. Matched t tests were used for these comparisons. One t test was calculated using the data from all 32 participants. A second t test was calculated using the data from only the 9 participants whose scoring rates had been independently significant. Neither analysis indicated a significant difference between the two tube conditions ($\bar{X}$ difference = 0.08, t [31] = 0.25, p = .80, two-tailed, and $\bar{X}$ difference = 0.41, t [8] = 0.74, p = .51, two-tailed, respectively). According to our understanding of the IDS model, psi scoring rate should be higher for the 2-tube than for the 8-tube condition (i.e., scoring rate should decline with "*n* length"). According to a direct psychokinesis or RA model, psi scoring rate should not depend upon the number of tubes being measured during a participant's "effort" period (i.e., scoring rate should be independent of "*n* length").[5] Thus, the absence of a 2-tube versus 8-tube scoring difference is more consistent with a remote action than with an IDS interpretation.

George Hansen (personal communication, May 28, 1988) raised an issue concerning the statistical analysis of the present study. The issue concerns the assumption of independence of measurements within a 15-minute period. He mentioned that substantial trial dependencies have been observed in some of the biological target systems used by other investigators and wondered whether similar dependencies might be present in this hemolysis work. If the individual "trials" (i.e., tube measurements) are not independent, then the t tests might not be appropriate. This independence issue may be addressed as follows:

1. Trial dependence would be more problematical in a situation in

[5] Some models of PK or RA could predict a diminished psi effect *at the level of the individual trial* (or at the level of the *individual tube*, in the present study) for long as opposed to short "*n* lengths" due to a kind of "watering down" or "spreading thin" effect of the increased number of targets at the greater *n* length. The total psi effect for the entire ensemble of large *n* events, however, should be comparable to that for the entire ensemble of small *n* events.

which *the very same target organism* participated in all trials of an extended measurement block—for example, placing a laboratory rat in a test apparatus for 15 minutes and measuring its activity 10 times (i.e., for 10 "trials") during that long period. In the present hemolysis experiment, a *different* tube of blood (with different target cells) was used for each of the "trials" (i.e., tube measurements) within a 15-minute epoch. This is analogous to making activity measurements in *10 different laboratory rats* placed sequentially in the measuring apparatus throughout a 15-minute period, all rats being selected or sampled from a common group colony cage.

2. The target tubes could not be randomized on an individual basis in the present study due to the nature of one of the experimental questions (i.e., the "few-versus-many-tubes" IDS question), which required multiple trials during a prolonged "effort" period, and therefore a blocked design. The order of the blocks (PCCP or CPPC) was randomized in order to control for any time-correlated systematic error.

3. Factors (e.g., temperature changes, handling differences, etc.) that might influence hemolysis rate were identified during the pilot and intermediate phases of the study and were eliminated or controlled so that they were no longer present or active in the formal experiment.

4. Before the formal experiment began, numerous test runs were conducted that involved multiple tube measurements under conditions identical to those of the experimental tests, but in the absence of psi influence attempts. Such tests indicated that the tubes displayed independent activities over time periods as long as those required for the completion of 20 trials. Inspection revealed no obvious trends or dependencies in the tube data. Furthermore, autocorrelation coefficients were calculated for all tube sets of this preexperiment series for which at least 20 sequential tube measurements were available. None of these autocorrelation analyses, each carried out for lag numbers 1 through 10, provided evidence for trends or dependencies.

5. Jessica Utts (personal communication, June 1, 1988) indicated that a positive correlation of the hemolysis values across time would inflate the t tests. Although indicating that there was no easy way to check for tube independence, she did calculate correlation coefficients of hemolysis rate versus the numbers 1 through 10, for each of the 64 sets of tubes (32 control sets and 32 protect sets) for which she was supplied the raw data. She reported that the results showed an average correlation of $-.03$ for the control sets and $-.001$ for the protect sets; this indicated that there was no obvious trend or dependency.

Taken together, these various findings and considerations are more consistent with an assumption of trial (tube) independence than with one of trial (tube) dependency within time blocks.

A different statistical issue was raised by a referee who inquired as to whether the data were sufficiently close to normality to justify the use of t tests. Utts (personal communication, June 1, 1988), in checking the he-

molysis data of the present experiment for normality, found that their histograms looked relatively bell-shaped and that nonparametric Mann-Whitney *U* tests calculated for the 32 subjects yielded results virtually identical to those of the *t* tests reported above (scoring rates were independently significant for 9 of the 32 individuals). She concluded that the *t* tests were valid (assuming the scores were independent).

Discussion

As expected, within- and between-subjects variability in this formal experiment was greatly reduced by the changes in experimental protocol that resulted from observations made in the pilot and intermediate phase experiments. This reduction in the experiment's "noise" level permitted the observation here of psi effects that could not be detected in the pilot study. Significant differences in rate of hemolysis between experimental (i.e., mentally "protected") and control blood samples were found in an extra-chance number of subjects.

It may be possible to discover important differences between subjects who exhibited significant positive scoring and those who exhibited significant negative scoring or chance scoring through detailed psychological analyses that would consider both short-term ("state") and more persistent ("trait") characteristics of the subjects. State analyses could focus upon the types of *mental strategies* used by the subjects in their attempts to influence the target cells. Some subjects, for example, employed a direct strategy of visualizing the blood cells in a very realistic manner, whereas other subjects employed a more indirect strategy of visualizing objects that were similar to the blood cells and possessed characteristics similar to those that protected cells might possess. Are more direct strategies more effective than indirect strategies based upon associations and symbolic representations? Trait analyses could be accomplished by asking all participants of the formal study to return to the laboratory for various personality assessments. Such assessments would, of course, be carried out by laboratory personnel who are blind to the subjects' hemolysis results. Initial assessments might involve psychological instruments such as the Myers-Briggs Type Indicator and the Participant Information Form, which have already been shown to correlate with other types of psi performance (e.g., Berger, Schechter, & Honorton, 1985; Honorton, Barker, Varvoglis, Berger, & Schechter, 1985). Possible *interactions* between state and trait factors could also be examined.

In the present study, several factors may have interfered with the emergence of even stronger psi effects. These factors were: (a) the presence of relatively large individual differences in the characteristics of the subjects, (b) the long durations of the psi "effort" periods and of the experimental sessions as a whole, and (c) the absence of real-time feedback to the subjects concerning the state of the target system. Factor (a) could be mini-

mized in future studies by more stringent selection of participants in terms of prior histories of successful bio-PK performance and of personality characteristics known to be correlated with psi performance. Factors (b) and (c) were necessitated by the "tube number" component of the present design (i.e., the assessment of two versus eight tubes in each 15-minute protect or control period). Lengthy "effort" periods were required to accommodate the measurement of eight tubes, and the requirement of keeping the subject "blind" to the number of tubes prevented the administration of feedback because that would have allowed the subject to keep track of the number of tubes measured. Future experiments unconcerned with a tube-number factor could include briefer psi-influence periods and could also provide feedback. It should be noted, however, that there exists a growing body of evidence that suggests that real-time sensory feedback to the subjects is not a necessary condition for the occurrence of strong psi effects (e.g., Berger, 1988; Braud, 1978b).

The major purpose of the present study was to determine whether a significant psi effect involving hemolysis could be observed using a large number of unselected subjects and an improved experimental protocol. The extrachance number of independently significant subject performances provides an affirmative answer to this question. One of two secondary goals of the study was to explore the issue of whether an IDS interpretation or an RA interpretation provides a better explanation of the results. (The other secondary goal was to study the "own" versus "another's" blood cells factor.) According to an RA interpretation, the subjects (or the experimenter) actually retard hemolysis rate in a causal or quasi-causal manner, yielding values that would not have occurred in the absence of influence attempts. According to an IDS interpretation, the experimental personnel take advantage of already existing fluctuations of hemolysis rate among different blood samples, "sorting" those values by the scheduling and timing of their trials so as to produce an effect that simulates a causal effect. It is important to remember that an IDS effect is still a psi effect, but an informational rather than a causal one.

There were several opportunities for intuitive data sorting in the present experiment. The person (M.S.) who provided the random schedule for blood source, tube condition, and tube number used a fixed rule that involved converting published weather information into an entry point for a table of random numbers. However, arbitrary decisions were still possible in assigning odd or even digits to the various sources, conditions, and tube numbers, and such decisions by M.S. provided possible entry points for IDS that could influence both between- and within-subject effects. A second possible source of sorting involved subject scheduling for the initial blood-drawing sessions. Which subjects happened to arrive at the laboratory on a given Monday evening for blood drawing would determine their places or positions in the test schedule, and hence the particular blood samples that would be assigned to them; this could provide additional IDS entry points. Subject-scheduling IDS effects could be mediated

by the experimenter (W.G.B.), by the laboratory personnel who suggested and scheduled potential subjects, and/or by the subjects themselves. A third possible source of sorting involved the experimenter's hemolysis measurements. By consciously or unconsciously altering the timing of his actions, he could determine the start point of the measured hemolysis curve, and this in turn could influence the hemolysis rate measure. The experimenter was aware of this possibility, and therefore he exercised great caution in maintaining the consistency and stereotypy of his laboratory technique in an attempt to obviate this factor. Only automated procedures could eliminate this factor, and even then, the elimination may or may not be absolute, depending upon the *completeness* of the automation. It is important to note that *deliberate* timing changes could influence only the tube number effect in the present experiment, because this was the only independent variable for which the experimenter was not blind. Because he was unaware of the blood source or of the scheduling of the protect versus control periods, any timing changes that could influence those two effects would necessarily have to be psi-mediated. It should be added that subjects may have influenced hemolysis rate indirectly by exerting a true, causal remote action influence upon the experimenter's timing behavior, so that what appears to be IDS by the experimenter could in reality be RA by the subject. As the reader will begin to appreciate, a truly definitive test of the IDS model, or even a definitive identification of IDS and RA components, is an exceedingly complex and difficult task.

The issue of whether the results of this experiment are described more closely by an IDS model or by an RA model was not resolved unequivocally by the mathematical analyses carried out at SRI International. Our own statistical analysis of the tube number factor did not indicate the presence of the significant difference between the 2-tube and 8-tube conditions that the IDS model would have predicted. The absence of a performance difference between the two tube conditions is more consistent with an RA (psychokinesis) interpretation than it is with an IDS (informational) interpretation of the obtained results.

In the blood experiments reported here, the hemolysis process occurred *in vitro* and was produced by osmotic stress. Caution should be exercised in the generalization of the results of this study to *in vivo* hemolysis. In the body, red blood cell lysis can occur through osmotic stress, but is more often contributed by other factors (Hillman & Finch, 1974; Ponder, 1971).

The rationale for selecting blood cells was that perhaps material that had once been part of the body might be more susceptible to distant mental influence than would be the case for more "alien" biological materials. At the very least, the use of such "familiar" material would be expected to increase the participants' motivational levels and hence increase the likelihood of positive results. Red blood cells were chosen as "targets" for these initial bio-PK investigations because their rate of hemolysis could be measured by means of the equipment and facilities available to us. However, this choice was not without its difficulties because the bio-

logical status of red blood cells is somewhat peculiar. On the one hand, human mature red blood cells have no nucleus, cannot reproduce, and have limited lifespans (approximately 120 days). On the other hand, as Ponder (1971) notes: "On metabolic grounds, mammalian erythrocytes are living cells; although in absolute terms the rates of respiration and of glycolysis are small, from the standpoint of cellular physiology the metabolism is far from negligible" (p. 366). Red blood cells certainly qualify as biological systems. In future cellular bio-PK investigations, however, perhaps the use of white blood cells or of artificially cultured neural cells may yield more dramatic results than those obtained in the present study.

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Mind Science Foundation
8301 Broadway, Suite 100
San Antonio, Texas 78209