Experimental

TOWARDS A COMPLEX SYSTEMS MODEL OF PSI PERFORMANCE

Dean I. Radin, Ph.D.

ABSTRACT

If psi is like any other human ability, and widely distributed in the population, than psi performance may be modulated by many of the same factors that affect other forms of human performance. To test this notion, 105 people participated in a series of four psi tests. Participants represented a broad range of age, belief, experience and personality type; data of 96 participants was adequate for further analysis.

A total of 149 variables were tracked per participant, including psi performance, psychological, sociological, meteorological, and solar-geophysical factors. The first test relied upon background ionizing radiation as the physical target, the second and third tests used electronic noise, and the fourth test involved a timing task. A single score was used to summarize each individual's psi performance in the four tests.

An artificial neural network was trained on the data of 72 participants to see if psi performance could be predicted based on eight variables representing an aggregation of 24 environmental, sociological and psychological factors. The network successfully learned to predict the performance of the remaining 24 people (correlation between prediction and actual performance was $r = 0.47$, $p = 0.01$), suggesting that psi performance in the laboratory, and probably in life, is influenced by some of the same environmental factors that influence other forms of human behavior.

KEYWORDS: Psi, comples systems, multi-variant models

INTRODUCTION

The concept of psi postulates unusual, direct interactions between the realms of mind and matter. If such interactions exist, then it is reasonable to expect that anything associated with mental functioning, such as fluctuations in attention, a headache, or lack of sleep, should also affect our experience and expressions of psi. The same is true for the matter side of the interaction. That is, it would be most unexpected if different physiological and physical conditions were not correlated with different degrees of psi performance.

Given the usual emphasis placed on the mental side of the equation, it is not surprising that the majority of experimental psi research has focused upon psychological factors such as mood, personality traits, motivation, expectation, and various altered states of consciousness.[1-3] Closely allied to the psychological is the psychophysiological, and in that realm there are also many relevant studies.[4,5]

Schmeidler conducted an extensive comparison of similarities and differences among empirical results from parapsychological, psychological and physiological studies.[6] She concluded that:

> Where the psi data were well replicated, the findings were consistent with psychological ones. These consistent patterns clustered in the social-personality area. Most were studies of attitudes and personality variables, of some interpersonal relations such as the experimenter effect, and of autonomic arousal, which is related to these.
>
> In contrast, psi research in perception, learning and other cognitive processes . . . gave null or ambiguous results. These results imply that psi does not function like sensory discrimination except for the most primitive responses, nor like cognitive processes except when those processes are modulated by personality.[6(p. 163)]

While psychological and physiological factors clearly deserve much more research, psi phenomena are unique because they are not just concerned with the mind—they also involve matter. As a result, the second largest domain of empirical data comes from physicists, who have studied how various physical factors may influence psi performance.[7-9] A third, more recent domain of research, has been environmental correlates of performance, especially the effects of planetary geomagnetism.[10-12]

These three research domains—psychological, physical and environmental—have provided valuable clues about the nature of psi, and they all remain fruitful independent domains of study.

The Systems Approach

A fourth approach is to view psi as a reflection of the operations of a multifaceted, interactive, nonlinear, dynamic system.[13-17] After all, psi is defined as an interaction between two (or more) processes: the process we call mind and the process called matter. This approach does not expect that a single "golden bullet," such as seeking a special state of consciousness or using a certain physical target, is going to provide the robust, at-will, macroscopic effects that will establish psi as assuredly as gravity. Rather, the systems view takes the position that psi will be described first in terms of complex multivariate assemblages, and only later (if at all) in terms of specific mechanisms. That is, psi may not be amenable to the usual reductionistic methods, but may require more holistic approaches.

A complex systems model also posits that any one factor, say personality trait, may be useful in explaining a small amount of the variance in psi effects, but that multiple combinations of many factors, including usual ones such as personality and mood, as well as more exotic factors such as sunspot numbers and amount of ozone in the air, will be required to create a model that can adequately account for the still-mysterious fluctuations observed in psi performance.

In previous studies, we explored aspects of a very simple system-theoretic approach by conducting psi experiments while simultaneously collecting psychological, physical, physiological, and environmental data.[13-15] In the present experiment, we expanded upon this idea by designing a series of four psi tests using three different target systems, and we collected data on participants' personal interests, their beliefs, psychological traits, and mood, the experimenter's mood and expectations, and local, regional, and global environmental factors.

Besides investigating the factors listed above, most of which can be justified on the basis of previous studies or face validity, we explored factors such as lunar phase, air quality indices, and daily counts of criminal and abnormal behavior recorded by an Emergency 911 Crisis Center. We believe that some of these factors (e.g., lunar phase) deserve a fair examination on the basis of historical and anecdotal lore linking the positions of heavenly bodies to human behavior[18,19] and to psi.[20,21] Other factors (*e.g.*, criminal and abnormal behavior) deserve to be examined because if, as Eastern philosophies maintain, and as much of psi research implies, all life is profoundly interconnected, then perhaps disturbances among the greater population may spread out and cause, to use a metaphor from the movie, Star Wars, a "disturbance in the force." Such subtle disturbances may affect distant human behavior, including psi performance.

There is a more pedestrian justification for collecting sociological variables like indices of domestic violence: Whatever environmental factors increase or decrease violence in the community probably affects everyone within the metropolitan region. If say, stormy weather arouses the nervous system, then storms may cause among other things, increases in aggressive behavior. If arousal turns out to be a correlate of psi performance, then domestic violence may be a useful (and relatively easy) indirect variable to track. Other factors, such as air quality and ozone levels, probably also affect human cognitive performance to some degree, and as such might also be expected to affect psi performance.

A Simplified, Hierarchical Model

The model used to focus our thinking is hierarchical, where we assume that the "arrow of causation" generally runs downwards, that is:

a) Changes in solar flux, lunar position, and geomagnetism directly affect weather patterns, and may also directly affect human physiology, cognition and performance.[22,23] Relevant variables include solar, geophysical, and mass behavioral measurements.

b) Changes in the weather affect human physiology, mood, cognition and performance.[24-26] Relevant variables are meteorological measures and local indices of criminal and abnormal behavior.

c) Changes in human physiology, mood, cognition and performance affect interpersonal relationships, motivation, attention, and intention.

d) Changes in motivation, attention and intention affect psi performance given that these aspects of the mind are intimately associated with psi phenomena.

This unidirectional model is clearly an over-simplified simplified version of what is really going on, but it serves as a useful starting point for understanding what is undoubtedly a highly interdependent system. The main reason the model is simplistic is the growing doubt that traditional reductionistic, materialistic methods can account for all observed phenomena, including the complex phenomena we call "life," and especially those functions of life we call cognition and consciousness.[27] In addition, the very concept of psi suggests that causation may not be unidirectional, but bidirectional, *i.e.*, flowing "upwards" starting with atomic particles, and "downwards," starting from the mind.[28]

EXPERIMENTAL EXPECTATIONS

The present study involved a heterogeneous, unselected population, e.g., participants were recruited from a wide range of backgrounds and beliefs, thus we did not expect to obtain statistically significant results in the four psi tests. In fact, we presumed that individual differences among the participants would wash out any consistent effects, and we expected (a) that some combination of environmental, psychological and sociological factors would modulate individual psi performance, and therefore (b) these factors could be used to reliably predict psi performance.

METHOD

PARTICIPANT PROCEDURE

The experiment was conducted in the Consciousness Research Laboratory (CRL) facilities in the Harry Reid Center for Environmental Studies on the campus of the University of Nevada, Las Vegas (UNLV). Posters advertising the experiment were placed around the campus and the local community, and a notice was posted in the weekly UNLV faculty/staff newsletter. A total of 105 participants were recruited between December, 1994 and December, 1995. Of these, 96 completed all aspects of the experiment, so subsequent analyses were based on data from these 96 people.

Each participant was greeted by a research assistant, Jannine Rebman (hereafter, E, the experimenter) and led into the Consciousness Research Laboratory. E briefly described the four experimental tests, and depending on the participant's curiosity or enthusiasm, she took an additional few minutes to discuss the nature of psi research in general. The participant then filled out a CRL Participant Information Form, a UNLV Informed Consent release, a Nowlis Mood Scale questionnaire,[29] and the Myers-Briggs Typology Indicator, Self-scoring Form G.[30] While the participant completed these forms, E moved to another area and completed an identical Nowlis Mood Scale questionnaire.

LABORATORY SETUP

After the paper forms were completed, E escorted the participant to a testing area in one of the CRL experimental suites. This area was separated from the rest of the lab by an acoustic wall partition; it contained a table which held a Dell Optiplex 486DX2/66 computer, a 17" Sony SVGA monitor, and a Robix™ robotics arm.

During many experimental session, to check on the integrity of the record data and experimental setup, a video camcorder was positioned above and behind the participant's head to capture on tape the computer, the keyboard, the robotics arm, and the participant. The experimenter casually pointed out the video camera, and none of the participants objected to its presence. Review of the video tapes showed that there was no reason to suspect that any of the recorded data were unreliable.

All participants were offered headphones playing ocean surf sounds to help mask occasional noises that could be heard in the hall outside the lab. About a quarter of the participants elected to use the headphones. During the experiment, the overhead fluorescent lights were turned off and a soft incandescent bulb was used for illumination.

TEST 1: CIRCLE

PROCEDURE

The first test was a software version of a "circle-of-lights" machine originally created by Helmut Schmidt.[31,32] The primary difference in this version was that the circle of lights were displayed on a computer monitor rather than using an actual circle of lamps, and background ionizing radiation was used as the physical target rather than radiation emitted by a piece of radioactive ore.

The participant was asked to gaze at a little green box on the screen and concentrate on causing the little box to move in a clockwise direction, following an imaginary circle. Every few seconds (randomly, when an ionizing particle was detected), the box would stop moving and turn red, whereupon the participant tried to will it back into the moving condition as quickly as possible. The Move and Stop conditions continued to alternate until 20 pairs of move-stop conditions had been completed for the first 50 participants (and 15 pairs for the last 46 participants).[33] After the participant completed two runs, E briefly discussed the results and then immediately proceeded to setup the next test.

DETAILS

The psi target in this test was the length of time between successive detections of radioactive particles. A computer-monitored Geiger counter, sensitive to alpha, beta, gamma and x-ray particles, was used to monitor background ionizing radiation (Model RM-60, from Aware Electronics). In this study, the RM-60 detected an ionizing particle on average every five seconds.

From the participant's perspective, the psi hypothesis was that their intention would cause the box displayed on the monitor to remain in the Move condition longer than in the Stop condition. However, we were not as interested in whether the participant would be able to successfully achieve this directional hypothesis (*i.e.,* Move > Stop) as in whether the variance of the Move—Stop difference would be greater than expected by chance.

The computer started the test in the Move condition,[34] that is the little box began to jump clockwise along an imaginary circle. Meanwhile, the software accumulated the number of times the box jumped. When the RM-60 detected an ionizing particle, the box stopped moving, and the software accumulated the number of (not displayed) jumps in the Stop condition. When the next ionizing particle was detected, the program shifted back to the Move condition, and so on, until all preplanned pairs of Move-Stop were completed. When the run was over, feedback was provided on the number of counts in the Move and Stop conditions. A typical run lasted between 2.5 and 3.5 minutes. Each participant conducted two runs.

To evaluate the results, a z score per run per participant was determined using the formula: $z = (X-\mu)/\sigma$, where X was the observed natural log-transformed difference Δ between Move and Stop, μ was the natural log-transformed mean Δ between Move and Stop scores for 1,000 unobserved control runs,[35] and σ was the associated standard deviation of Δ for the control runs. The two z scores per participant resulting from the two runs were squared and then summed into a single *z-squared* score used to represent a given participant's overall performance on the circle test.

TEST 2: DUCKS

PROCEDURE

The second test asked the participant to mentally herd a troupe of 50 randomly moving ducks (small colored boxes) appearing in the center of the computer monitor display.[36] The participant was informed that the test would end if any of the ducks touched an "electric fence" (a blue line) surrounding the edge of the screen, and thus the goal was to keep the ducks "alive" as long as possible.

Participants conducted two runs, and at the end of each run, the program provided feedback in terms of the length of time (in terms of steps, defined below) that the ducks were kept "alive."

DETAILS

The physical target in this test was an electronic random number generator (RNG) which operated through the serial port of the computer.[37] The controlling software[34] took successive truly random numbers modulo 4 from the RNG, randomly assigned a direction (0 = up, 1 = down, 2 = left, 3 = right) to each little box, randomly assigned another direction for the whole group of boxes direction (up, down, left, right), then redrew the screen. This created the illusion of ducks moving about randomly on the screen, as a flock.

One step in this test was defined as a cycle in which each individual box was moved once. The number of steps obtained before a run ended was the outcome measure, and this number was provided as performance feedback. A typical run lasted from 4 to 6 minutes.

A Monte Carlo approach was used to determine the chance expected number of steps. The computer program was allowed to run unobserved 3,000 times, and the resulting distribution of steps-to-stop was used to determine an empirical chance mean and standard deviation.[38] Log-transformed values were used to form standard normal deviate scores using the formula: $z = (X-\mu)/\sigma$, where X was the log-transformed number of steps per run per participant, and μ and σ were from the Monte Carlo simulation. As before, a single *z-squared* value was formed to summarize each participant's performance on the two runs.

TEST 3: ROBOT

PROCEDURE

This experiment asked the participant to concentrate on a six-axis computer-controlled robot arm and hand[39] to cause it to move over, pick up a piece of candy (an almond M&M), move to another location, and then drop the M&M into a cup. The M&M served both as feedback and as a small motivational treat. The task was to get the candy as quickly as possible.

To begin, the participant selected an M&M candy from a bin and placed it on a pedestal. He or she could talk, plead, or scream at the robot, but was not allowed to touch it, the table on which it rested, or anything else while the experiment was in progress. E said that the M&M could be eaten if the robot successfully dropped it into the cup (to maintain motivation, it was not explained that the robot would always drop the candy eventually). This test was run twice. A typical run lasted from 1 to 5 minutes, and most participants wanted to try it a few more times because it was great fun (and they enjoyed the M&Ms).

DETAILS

The hypothesis was that mental intention would cause the robot to drop the M&M into a cup faster than the mean length of time it would take when the robot operated unobserved. A computer program was used to retrieve 50 successive random bytes from an electronic RNG (the same one used in the second experiment).[40] These bytes were used to create a z score by summing the resulting 400 bits and applying the formula $z = (X - 200)/10$, where X was the total number of 1 bits generated in 400-bit random sample.

These z scores were used to move the robot arm through a state space. Table I shows how z scores were transformed into one of five possible states, and Table II shows how these states were mapped into movements. From Table II, we see that the robot could move into 9 discrete states, from the initial starting position, to incremental movements towards the M&M candy, picking up the candy, moving towards the cup, and finally dropping the candy into the cup.

Table I
Transitions between output of RNG, terms of absolute value of the z score, into one of five possible state transition states.

IF	THEN State =
$\lvert Z \rvert < 1.0$	0
$1.0 \leq \lvert Z \rvert < 1.5$	1
$1.5 \leq \lvert Z \rvert < 2.0$	2
$2.0 \leq \lvert Z \rvert < 2.5$	3
$\lvert Z \rvert < 2.5$	4

To progress in this test, the RNG had to generate z scores ≥ 1. Each time the RNG produced a $z < 1$, the robot would either move backwards or remain in the same position, depending on its current state. A *step* in this test referred to the following cycle: (a) the RNG generated an output, (b) a z score was transformed into a position state, and (c) the robot moved to that state. The total number of steps it took to drop the M&M in the cup was used as the score for the test, and this score was provided at the end of each run as feedback.

The minimum number of steps in this test was 2, which would occur if the RNG produced two successive samples each with $|z| > 2.5$. The maximum number of steps was theoretically infinite. The actual probability distribution was determined by Monte Carlo simulation, running the robot program unobserved 1,000 times. These control scores were log-transformed to determine the control mean and standard deviation.

As in the Circle and Ducks tests, the end statistic for this test was a z score per run, formed as $z = (X - \mu/\sigma$, where X was the log-transformed number of steps for a given participant per run, and μ and σ were the control log-transformed mean and standard deviation. And as before, a single *z-squared* value was used to represent performance over the two runs.

Table II
State transition table for the Robot test.

State	Case	Move to state(s)
Startup	0	Startup
	1	A
	2	A→B
	3	A→B→C
	4	A→B→C→Pickup
A	0	Startup
	1	B
	2	B→C
	3	B→C→Pickup
	4	B→C→Pickup→D
B	0	A
	1	C
	2	C→Pickup
	3	C→Pickup→D
	4	C→Pickup→D→E
C	0	B
	1	Pickup
	2	Pickup→D
	3	Pickup→D→E
	4	Pickup→D→E→F
Pickup	0	Pickup
	1,2	Pickup→D
	3	Pickup→D→E
	4	Pickup→D→E→F→drop
D	0	Pickup
	1	E
	2	E→F
	3,4	E→F→drop
E	0	D
	1	F
	2,3,4	F→drop
F	0	E
	1,2,3,4	F→drop
drop		

Test 4: Video

PROCEDURE

In the fourth and final test, participants viewed a series of 10 digital video clips. Each clip lasted from 30 seconds to a minute, and was displayed in a 2 x 3 inch area on the computer monitor. To see each successive clip, participants clicked a mouse button.

At the end of each clip, a window popped up and presented two questions. These were answered by moving a horizontal slider bar. The first question asked how participants *felt* about the clip they just viewed and the second asked how much more of the clip they wished to *see*. In both cases, the scale ranged from -50, meaning they felt very negatively about the clip or they wished to see less than they actually saw, to +50, meaning they felt very positively or wished to see more of the clip. After answering the two questions, the screen cleared to prepare for the next trial. No feedback was provided on how well they did in this test, nor were the purpose or underlying hypothesis explained.

DETAILS

The hypothesis was that how participants felt, or how much they wished to see, about each clip would correspond to the length of the clip that they actually saw. To test this, the length of each video clip was determined randomly on each successive playback. The controlling software[41] for this test set the VisualBasic's pseudorandom seed number to the current clock time when the participant clicked the button to view each successive video clip. The software pseudorandom generator then produced a random number which determined the length of the clip.

The pseudorandom number R generated per clip was ±60, uniformly selected at random. If the pseudorandom number returned for a given clip was zero, the video would stop one frame *before* a specially selected climactic moment. If R was positive, the video clip would be shown up to the climax plus R additional frames. If R was negative, the video clip would be shown up to R frames before the climax. Because video frames were displayed at 15 frames per second, the range of real-time variability in each clip was ±4 seconds. Each clip ran for about 30 seconds before the climax was (or could be) reached.

Ten videos were selected from a pool of 500 such clips off a CD-ROM called the "Video Almanac," available from *The Software Works*. The clips are all historical events from the 20th century, mostly depicting scenes from (North) American history. Tables III and IV list the videos and describe the climactic events.

The results were evaluated as two correlations. Using the term "*delta*" to mean the difference between the actual and nominal (climactic) stopping points on each clip, the two correlations were (1) between *delta* and how the participant reporting *feeling* about the clip, and (2) between *delta* and how much more the participant wanted to see the clip. Each correlation was transformed into an equivalent t-score for 10 clips (8 df), and the probability corresponding to that t-score was transformed into a one-tailed *z*. The end-result was two z-squared scores per participant.

VARIABLES

The purpose of this study was to see whether psi performance could be predicted in a multivariate model. After considering about 250 possibly relevant variables, we settled upon 149 that were reasonable to acquire or measure given the resources we wished to expend on this exploratory study. The variables fell into 8 categories: **Mood** (24), **Personality** (19), **Beliefs** (39), **Meteorology** (14), **Solar/Geophysical** (6), **Abnormal Behavior** (21), **psi** (21), and **Composite Factors** (5). Missing from this list are physiological and chronobiological (circadian rhythm, ultradian rhythm, menstrual cycle, etc.) variables, which we plan to add to a future version of this experiment.

PSI VARIABLES

Table V lists 21 measures related to psi performance on the four tests. A single, overall psi measure was formed from the combination of 7 chi-squared scores corresponding to the two runs in the Circle, Duck, and Robot tests, and to

Table III

Description of clips used in video test for the first 50 participants.

Clip	Description	Clip Stopped
Pearl	F. D. Roosevelt saying the phrase, "December 7, 1941, a day that will live in infamy."	Just after FDR dramatically pauses after saying the words, "that will live. . ."
Bomb	Countdown and explosion of the first above-ground atom bomb tests at Bikini Island	The frame before the atom bomb explodes.
Muscles	Mr. America body-building contest of 1949.	Just before the scene switches to a shot of an entranced woman gazing at the muscle man.
Chimp	A chimpanze picks up a cat and washes it in a sink.	Just before the chimp unexpectedly puts the cat into the sink.
King	Martin Luther King's famous speech, "I've been to the mountain top."	Just after King says "I've seen. . ." The rest of this famous phrase is ". . . the promised land."
JFK	John F. Kennedy's inaugural speech, "Ask not what your country can do for you. . ."	Just after JFK says, with a dramatic pause, "Ask not. . ."
RFK	The last appearance of R. F. Kennedy speaking to supporters at a hotel, followed by the chaotic scene when he was assassinated.	Just before the video clip shifts to the assassination.
Nixon	Richard Nixon's resignation speech	Just before Nixon says that he is resigning.
Reagan	Attempted assassination of Ronald Reagan outside a hotel in Washington	Just before the shots are heard.
Challenger	Launch of ill-fated Space Shuttle Challenger.	Just before Challenger explodes.

Table IV
Description of new video clips used for the last 46 participants
These were used in place of the clips in Table III labeled
"Muscles", "Nixon" and "Pearl."

Clip stopped	Description	Clipped
Hitler	Hitler and Nazi newsclips	Just before Hitler dances a silly little jig dance.
Woodstock	Singer at Woodstock	Just before people are shown swimming naked in a pond.
Alcohol	Clip of Carry Nation espousing the evils of alcohol	During a particularily ranting sequence of how alcohol makes you sick

the correlation related to the "feel" question in the Video test. (The Video test "see" correlation results were not added to the overall psi measure because the results of the "feel" and "see" questions were highly intercorrelated.)

SOLAR-GEOPHYSICAL VARIABLES

Table VI lists six solar and geomagnetic variables retrieved from the Solar Daily Geophysical Bulletin (SDGB), a service from the University of Lethbridge, Canada. The SDGB summarizes and redistributes daily geophysical measures collected primarily from the National Oceanographic and Atmospheric Association.

METEOROLOGICAL VARIABLES

Local weather data was retrieved from the Las Vegas, Nevada, branch of the National Weather Service and by a Davis Instruments weather monitor in our laboratory. The 14 variables are listed in Table VII.

Table V
Psi variables recorded in the four experiments.

Variable Name	Meaning
circleZ1	circle of test z score, run 1, per participant
circleZ2	circle test z score, run 2
circleZsq1	circled test z squared, run 1
circleZsq2	circled test z squared, run 2
circle	Combined circle chi-squared test = circzsq1 + circzsq2, 2 df
duckZ1	duck test z score, run 1
duck Z2	duck test z score, run 2
duckZsq1	duck test z squared, run 1
duckZsq2	duck test z squared, run 2
duck	combined duck chi-squared test, 2 df
robotZ1	Robot test z score, run 1
robotZ2	Robot test z score, run 2
robotZsq1	robot test z squared, run 1
robotZsq2	robot test z squared, run 2
robot	overall robot chi-squared test, 2 df
videoZ1	video test correlation, delta vs. "feel"
videoZ2	video test correlation, delta vs. "see"
videoZsq1	video test z squared, for "feel" correlation
videoZsq2	video test z squared, for "see" correlation
video	overall video chi-squared test, 2 df
psi	chi-squared =circle+duck+robot+videoZsq1, 7 df

Table VI
Solar and geomagnetic variables monitored in the experiment.

Variable Name	Meaning
SSN	Sunspot number
Flux	Solar flux
In (AP)	Natural log of the Ap index
SSN1	Sunspot number the day before the test
Flux1	Solar flux the day before the test
In (AP1)	Natural log of the Ap index the day before the test

Table VII
Meterological variables monitored.

Variable Name	Meaning
TempOut	Outdoor temperature, degrees Fahrenheit
TempIn	Indoor temperature, degrees Fahrenheir
HmdOut	Outdoor relative humidity, percent
HmdIn	Indoor relative humidity, percent
BaroOut	Outdoor barometric pressure, inches Hg
BaroOut 1	Outdoor barometric pressure the day before the test
BaroIn	Indoor barometric pressure
BaroCondOut	Direction of change for outdoor barometric pressure, up, down, or steady
BaroCondIn	Direction of change for outdoor barometric pressure, up, down, or steady
WindDir	Wind direction, to nearest of 8 points on the compass
WindSpd	Wind speed, miles per hour
PM	Particulate matter under 10 microns, in parts per million, from μgrams/m^3
CO	Carbon monoxide, parts per million, calculated from μgrams/m^3
Ozone	Ozone, parts per million, calculated from μgrams/m^3

Table VIII
Participant information variables monitored in the experiment.

Variable Name	Meaning	Variable Range
casual expt	conducted casual psi experiments?	yes/no
psi expt	conducted formal psi experiemnts?	yes/no
coincidence	amount of coincidences experienced	1-7
dream recall	amounr of dream recall	1-7
lucid dream	amount of lucid dreaming	1-7
day dream	amount of day dreaming	1-7
fantasy	amount of fantasizing	1-7
vivid image	amount of vivid imagery	1-7
lose aware	frequency of losing awareness of surroundings	1-7
lose time	frequency of losing track of time	1-7
control	degree of control	1-7
believe luck	belief in luck	1-7
lucky?	how lucky are you	1-7
early late	tend to arrive early or late	1-7
reserved	reserved or outgoing	1-7
neat casual	neat or casual	1-7
think feel	tend to think more or feel more	1-7
imagery	degree of imagery	1-7
competitive	prefer to compete or cooperate	1-7
comp use	amount of computer time	1-7
comp expertise	amount of computer expertise	1-7
machines	how machines perform for you	1-7
exercise	amount of exercise	1-7
mental disc	amount of mental discipline training	1-7
phys disc	amount of physical discipline training	1-7
hrs sleep	hours of sleep per night	hours
get sleep?	get enough sleep?	1-7
I have psi?	belief that you have psi	1-7
telepathy?	experience with telepathy	1-7
esp?	experience with ESP	1-7
precog?	experience with precognition	1-7
is psi real?	belief that psi is real	1-7
pk exper	experience with PK	1-7
is pk real	belief in pk	1-7
family psi	family history of belief in psi	1-7
psi relative	family member has psi	1-7
dissociate	how easy it is to dissociate	1-7
demo in lab	believe psi can be demonstrated in lab	1-7
demo psi?	believe you will demonstrate psi now	1-7

Table VIII lists 39 personality and personal interest variables from the CRL Participant Information Form.

CRIMINAL AND ABNORMAL BEHAVIOR VARIABLES

Table IX lists 21 measures of daily criminal and abnormal behavior retrieved from the Las Vegas (Nevada) Metropolitan Police Department's 911 Crisis Center and the Clark County (Nevada) Department of Mental Health.

Table IX
Abnormal behavior monitored in the experiment.

Variable Name	Meaning
Accidents	All forms of accidents
HitRun	Hit and run accidents
AccInjury	Accident resulting in injury
AccProp	Accident involving property
Suicide	Suicide
AttSuicide	Attempted Suicide
Gun	Person with a gun
Knife	Person with a knife
Weapon	Person with another sort of weapon
Assault	Assault
AssWeapon	Assault with a weapon
Domviol	Domestic violence
Sick	Physically ill person
SexAss	Sexual Assault
AttSexAss	Attempted sexual assault
Animal	Animal disturbance
Civil	Civil disturbance
IndecExp	Indecent exposure
Mental	Mentally ill person
Strange	Patients admitted to 72 hour county psychiatric facility
Psycho	Patients admitted to county psychiatric facility as psychotic

MOOD VARIABLES

In the Nowlis Mood scale, the participant is asked to check off their feelings about 33 adjectives describing various mood-states. Responses to these adjectives are combined to produce 12 mood subscales, as shown in Table X. Both participant and experimenter filled out the mood scales prior to taking the psi tests, resulting in a total of 24 variables (2 sets of 12 each). The twelve scales are intercorrelated and are combined into a single measure of mood.

Table X
Mood variables collected in the experiment.

Mood Scale	Meaning
Aggression	defiant, rebellious, angry, grouchy, annoyed, fed-up, furious, ready to fight
Anxiety	fearful, jittery, nervous, afraid, frightened, panicky, upset, terrified, worrying
Sutgency	carefree, playful, witty, lively, talkative
Elation	elated, overjoyed, pleased, refreshed and lighthearted
Concentration	careful, introspective, decisive, efficient, attentive, serious, intent
Fatigue	drowsy, dull, sleepy, tired, worn-out, sluggish, weary
Vigor	active, energetic, vigorous, bold, strong, industrious, full of pep, quick, lively
Social Affection	affectionate, forgiving, warmhearted, cooperative, good-natured
Sadness	regretful, sad, worthless, helpless, unhappy, discouraged, blue, lonely, gloomy
Skepticism	skeptical, suspicious, dubious
Egotism	egotistic, self-centered, boastful
Non-chalance	nonchalant, leisurely, at rest, quiet, placid

PERSONAL AND PERSONALITY VARIABLES

Table XI lists 19 background, personality, and miscellaneous variables. Note that for the last group of 46 participants, the Myers-Briggs Type Inventory (MBTI) was not included in our battery of paper tests because we found in preliminary analyses after 50 participants had been run that these personality variables were not particularly predictive of psi performance. Eliminating the MBTI paperwork also represented a savings of 15 to 20 minutes per participant per session, which made it easier to recruit new participants. That is, it was easier to attract participants by asking for just over 30 minutes of their time, rather than requiring them to take a full hour out of their schedule.

Table XI
Personal and personality variables collected in the experiment.

Category	Variable Name	Meaning
Date/Time/ID	Subj	Participant code number
	Date	Date of test
	Time	Time of time
Background	BDate	Participant birth date
	BPlace	Participant birth place
	Nationality	Participant nationality
	Occupation	Participant occupation
	Education	Participant highest educational level
Expectation	ExpExpect	Experimenter's expectation of success
Personal	Gender	Participant gender
	Age	Participant age
Personality	E	Myers-Briggs Type Inventory Extrovert scale
	I	MBTI Introvert scale numerical score
	S	MBTI Sensing scale
	N	MBTI Intuitive scale
	T	MBTI Thinking scale
	F	MBTI Feeling scale
	J	MBTI Judging scale
	P	MBTI Perceiving scale

COMBINED FACTORS

To help simplify further analyses, a principal components analysis[42] was used to collapse intercorrelated variables into composite factors that we called (see Table XII) **Weather**, **Belief**, **Abnormal**, **Smood** (subject mood) and **Emood** (experimenter mood).

Table XII
Composite factors formed by principal components analysis.

Factor Name	Combination of variables
Weather	baroout, ozone, SSN (from table VII)
Belief	coincidence, esp, pk experience (from table VIII)
Abnormal	attsexass, hitrun, civil, siucide (from table IX)
Smood	positive mood=(surgency+elation+vigor+social affect) - negative mood=(aggression+anxiety+fatigue+sadness) (Table X)
Emood	positive mood=(surgency+elation+vigor+social affect) - negative mood=(aggression+anxiety+fatigue+sadness) (Table X)

INDIVIDUAL TEST RESULTS

POPULATION

Of the 96 participants, 49 were women and 47 were men. The average age was 37.2, minimum age was 11, maximum was 75. Educational background included 1 person in elementary school, 25 with high school degrees, 41 with BS or BA degrees, 20 with MS or MA degrees, 7 with PhD degrees, 1 with a DMD (dental) degree, and 1 with a PhD, MD degree. Professions included anthropologist, biologist, chaplain, chemist, computer scientist, construction contractor, dentist, editor, engineer, librarian, medium (psychic), military officer, paramedic, and physician. Participants' citizenship was primarily from the USA, with the remainder from Britain, India, Vietnam, and Italy.

TEST 1: CIRCLE

The task was to cause the number of steps in the Move condition to exceed the number of steps in the Stop condition. Results shown in Table XIII, indicate that the combined *z* scores (SZ) and variance tests (Chi, 96 df) were unremarkable.

Table XIII
Summary of Circle test results. SZ refers to the combined Stouffer z score, used to test directional results, and Chi refers to the sum of z-squares, used to test variance.

	run 1	run 2	run 1	run 2
SZ	0.05	-0.18		
Chi			94.8	91.9
p	0.48	0.57	0.52	0.59

TEST 2: DUCKS

The procedure required the participant to mentally intend the ducks to remain "alive" for longer than the empirically determined control mean. During the course of the test, it became clear that participants applied high concentration to attempt to "save" the ducks, and this tended to exhaust them quickly. Results shown in Table XIV indicate that ducks tended to "die" slightly sooner than expected by the control runs, but again, there is nothing remarkable about these results.

Table XIV
Summary of Ducks test results.

	run 1	run 2	run 1	run 2
SZ	0.09	-0.04		
Chi			94.2	94.8
p	0.54	0.52	0.53	0.51

TEST 3: ROBOT

The prediction in this test was that the intention of obtaining the candy as soon as possible would cause the robot to drop the M&M candy faster than the Monte Carlo-determined chance mean *(i.e.,* negative *z* scores). Results in Table XV show slight tendencies in the opposite direction, and nothing remarkable in the variance tests.

Table XV

Summary of Robot test results.

	run 1	run 2	run 1	run 2
SZ	0.21	0.18		
Chi			90.8	95.0
p	0.58	0.51	0.63	0.51

TEST 4: VIDEO

The hypothesis here was that the length of each video clip would correspond to how the participant felt about the clip or how much they wished to see of the clip, thus positive correlations were predicted. Table XVI shows the results, indicating nothing interesting about the directional hypotheses, but possibly something interesting about the variance tests.

Table XVI

Summary of Video test results, where *Z* corresponds to the equivalent t score for the correlations determined in this experiment.

	run 1	run 2	run 1	run 2
Z	-0.83	0.37		
Chi			119.1	121.4
p	0.80	0.35	0.06	0.04

Further investigation of the video test data indicated that the correlation between how people felt about a video clip and how much of the clip they actually *saw* (only for those cases in which how they felt was consistent with how much they wished to see) was $r = -0.573$, $t = -2.521$, $p = 0.024$ (two-tail), N = 14.[43] This correlation, shown in Figure 1, means that negative clips were seen longer than expected, and positive clips were seen shorter than expected.

While this is opposite to our original hypothesis, such an outcome is certainly consistent with the escalating levels of sex and violence shown on television and in the movies. We *(i.e.,* the viewing audience) may complain loudly about such things, but clearly people prefer to watch negative and aggressive shows because they are more arousing than positive, pleasant shows. We suppose the message is that if we are going to seek vicarious experiences to fantasize about, we would rather seek exciting, risky experiences than boring (even if pleasant) experiences.

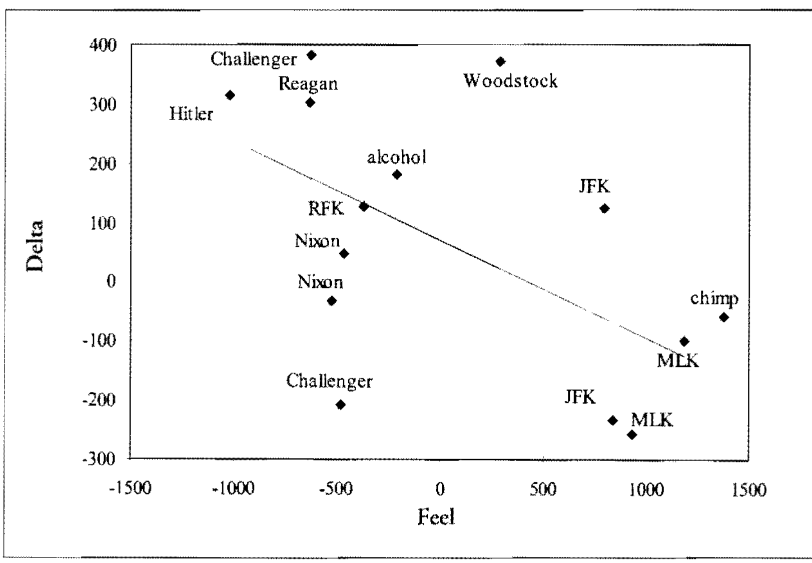

Figure 1. Correlation of the sum of Feel scores vs. the sum of Delta scores (deviation between the actual and nominal stopping points in the video clip) in the video experiment. Notice that the positive Feel clips (e.g., JFK speech) were associated with the video clip stopping too soon (negative Deltas), while the negative Feel clips (e.g., Hitler) were associated with the video stopping after the climactic points (positive Deltas).

Overall Results

To evaluate the overall results, we combined the z-squares for the two runs in the Circle, Ducks, and Robot tests, and the z-squared result for the Video "feel" correlation. This produced a chi-squared distributed score with 7 degrees of freedom. Then we summed these scores across all 96 participants to produce a single chi-squared score with 96*7 or 672 degrees of freedom. The z-squared sum was 683.0, $p = 0.375$. Of the 96 people, 7 had overall results at $p < .05$, which is not significant (cumulative binomial $p = 0.108$).

Thus, by the usual criteria the combined results of four psi tests are not interesting. At this point, the discussion sections in conventional experimental studies launch into extensive apologia, examining all the possible reasons why the results were not significant, and then end with the obligatory call for further research. However, this apparently nonsignificant result is precisely where the present study begins.

PREDICTIVE MODEL

At this point we have three nonsignificant experiments, one possibly interesting experiment, and a soup of 149 variables. To form a predictive model, we took the following steps. First, we needed a variable to predict. We decided to use the probability associated with the overall chi-squared value for each of the 96 participants because these values were more or less uniformly distributed, as shown in Figure 2.

Second, we needed to select the variables that would be used to predict psi performance. At first glance it may seem reasonable to use all 100+ environmental, psychological, and abnormal variables, however there are two reasons we should not: (a) many of these factors are intercorrelated and provide redundant information that may confuse the modeling technique, and (b) typically it is desirable to have at least 10 times as many examples of the data as predictor variables. Because we have only 96 examples of individuals' data, we are limited to something like 9 predictors. In addition, because we would like to train the model on say, 75% of the data, and then test it on 25% that it had not seen before, we are really limited to something like 7 or 8 predictors.

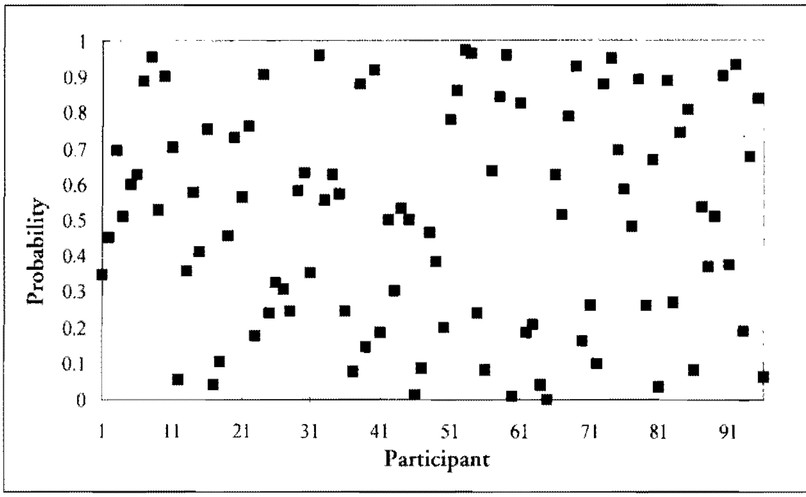

Figure 2. Probability of each participant's overall results.

To help select which predictors to use, we began by examining the composite factors listed in Table XII. These factors were potentially useful because they were formed by combining numerous other variables through principal components analysis. Based on visual inspection of the scatterplots between the composite variables and psi, we decided to use:[44]

a) **Emood** to capture the experimenter's mood; this collapsed 12 variables into one.

b) **Belief** to capture the participant's ideas and experience about psi; this collapsed 3 variables into one.

c) **Abnormal** to capture what might be called environmental demographics; this collapsed 4 variables into one.

d) one weather variable (**windspeed**),

e) two demographic variables (**domestic violence** and **animal disturbances**) and

f) two personality variables (**daydream and early/late**).

In sum, our 8 predictors were based upon 24 psychological, environmental and demographics variables. The neural network used to predict psi had 8 inputs (*i.e.*, the 8 predictor variables), 14 hidden nodes and 1 output (*i.e.*, psi).[45] The number of hidden nodes was determined through the use of a Genetic Training Option[46] which was used to optimize the network's performance.

For training the network, first data from all 96 participants were shuffled to remove the chronological nature of the original records, and then 75% of the data items (72) were randomly selected for the training dataset. The network was trained until all of the training examples resulted in individual error rates (*i.e.*, the difference between the original data and the network's prediction) less than 0.1. This took about 2,000 runs through the network.

The testing dataset consisted of the remaining 24 data items that the neural network had not yet "seen." These items were run through the trained neural network once, and the network's output was compared to the original data. If the network learned a viable model of the data, then this model should transfer to new data, and the correlation between the network output and the original data should be positive. Thus, a one-tailed test was appropriate. The results, shown in Figure 3, are surprisingly large, $r = 0.473$, $p = 0.0098$ (one-tailed).

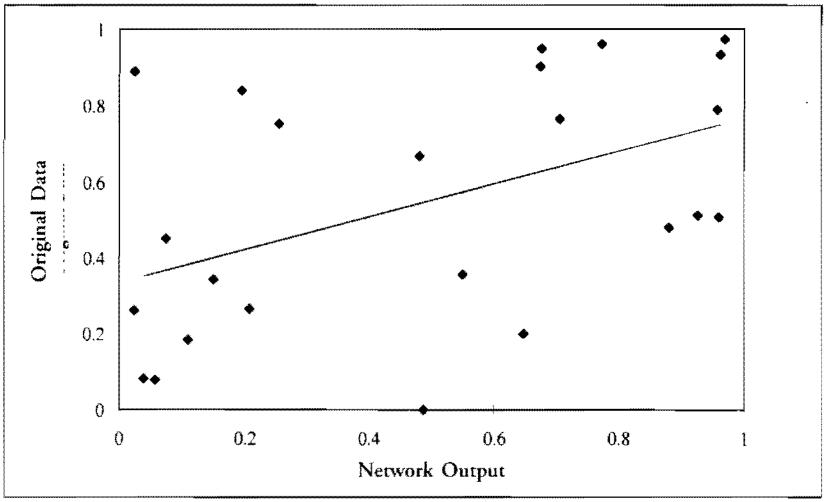

Figure 3. *Comparison of original data and predicted output for data that the neural network had not seen before,* $r = 0.473$, $p = 0.0098$ *(one-tailed).*

A cursory examination of some the relationships among the predictors suggests that the model makes sense.[47] For example, Figure 4 shows how the variables **Daydream**, **Domestic Violence**, and **psi** were related. This indicates that psi performance improved (*i.e.*, the combined probability of the four tests decreased) for participants who reported that they do not tend to daydream, mainly when environmental conditions were such that domestic violence was low. This makes sense because people who do not tend to daydream are ordinarily alert to their surroundings, and thus they may perform best when the environment does not disturb, arouse, or distract them. Such calm times are presumably reflected by lower levels of domestic violence.

By contrast, psi performance also improved for participants who reported that they do tend to daydream, mainly when environmental conditions were associated with higher levels of arousal, as reflected by higher levels of domestic

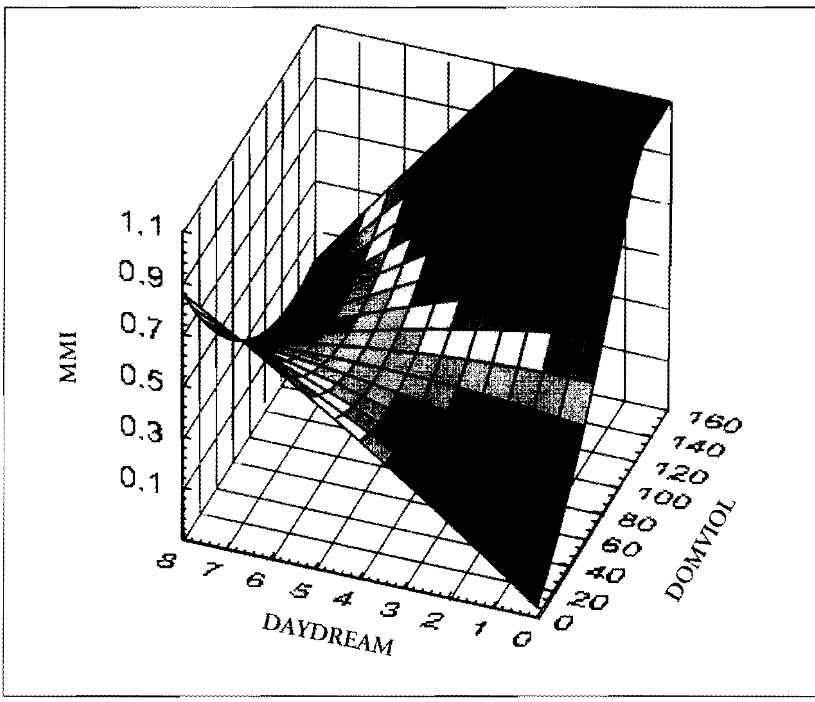

Figure 4. *Relationship among two predictors and psi (shown as MMI for mind-matter interaction.*

violence. This makes sense because daydreamers may need to be externally aroused, e.g., by the environment, to pull them out of their reverie so they can concentrate on the task at hand.

DISCUSSION

As anticipated, due to the heterogeneity of the test population, there was no independent evidence for psi effects in three of the four tests, and overall the combined results were null. This is where most experiments end.

But the question explored by this study was: Why does mind-matter interaction performance vary so much from one person to another, and from one experiment to the next? We speculated that much of the variance arises because psi performance is inextricably embedded in and is modulated by a complex *system* of interacting variables, including psychological, sociological, physical and environmental. The question is then reframed into: Which set of variables, out of an infinite number of possibilities, best account for psi performance, and can we used those variables to predict performance on an individual basis?

The answer to the latter question is yes, as shown in Figure 3: The neural network was able to transfer its learned model of psi performance to new data. Recall that because we were examining correlates of performance, we specifically sought out people who would provide as much variation as possible among the personality and personal interest variables, and we ran the experiment over the course of a full year to ensure variation among the environmental conditions. We expect that both psi performance and predictive capabilities can be significantly improved by moving to homogeneous populations or to single-subject, longitudinal studies with selected, "talented" individuals.

IMPLICATIONS

One of the most important implications of the present modeling effort is that it points towards lawful boundaries in psi performance. This is important because one of the criticisms of psi phenomena is that "nothing seems to matter."

That is, one of the main reasons that psi is considered to be anomalous is that the phenomena do not seem to be affected by the ordinary boundaries of time and space, and they cannot be "turned on and off" like some of the more robust phenomena we know.

How to study a phenomenon that shows no covariates, limitations or boundaries is difficult to imagine. But if covariates of psi performance can be found, and we suspend our disbelief about the usual limitations of time and space, then the reality of psi is no longer unimaginable. Lawful regularities associated with boundary conditions would herald the beginning of predictive models of these phenomena, and the designation "anomalous" would quickly evaporate.

The present study suggests that while the underlying mechanisms of psi are still quite mysterious, there are variations in psi performance that make sense from psychological and physiological points of view, and are consistent enough to allow the formation of predictive models.

CONCLUSION

A series of 4 psi tests run by 96 participants showed no overall evidence for psi. However, a model of psi performance based on 8 environmental, psychological and demographic predictors, and trained on data from 72 participants, was able to significantly predict individual psi performance in 24 new individuals. This suggests that (a) psi performance resembles other forms of human performance in that it is modulated by numerous "external" factors, (b) psi is widely distributed in the population, and (c) psi performance can be significantly enhanced by taking into account a wide range of environmental factors.

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CORRESPONDENCE: Dean I. Radin, Ph.D. • Consciousness Research Laboratory • 3481 Lorilou Lane B • Las Vegas, NV 89121

ACKNOWLEDGMENTS: The Consciousness Research Laboratory has received grant supporr from the Bigelow Foundation (Las Vegas, NV), the Parapsychology Foundation (New York, NY), the Institute fur Grenzgebiete der Psychologie und Psychohygiene (Freiburg, Germany), the Bial Foundation (Porto, Portugal), and the Society for Psychical Research (London, England).

We also thank Kurt Zimmer of the Las Vegas Metropolitan Police Department for providing the crime statistics, and the United States Weather Service, United States Geological Society, National Oceanic and Atmospheric Association, Clark County (Nevada) Health Department, Nevada Department of Vital Statistics, Las Vegas Crisis Center, and the State of Nevada Department of Mental Health for providing other data used in this study.

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33. Minor changes in the tests were introduced after the first 50 participants to speed up the data collection process.
34. The program was written by the author in Microsoft QuickBasic.
35. These control means and standard deviations were based on either 20-pair runs or 15-pair runs for the first 50 and last 46 participants, respectively.
36. The first 50 participants saw 50 boxes, the last 46 saw 25 boxes.
37. The source of randomness was electronic noise generated by two independent analog Zener diodes. This truly random RNG was designed by, and extensively tested for randomness by Prof. Dick Bierman of the University of Amsterdam.
38. Two Monte Carlo simulations were run, one for 50 ducks (boxes) and the other for 25, corresponding to the first 50 and last 46 participants, respectively.

39. The robot, called Robix, is from a company called Advanced Design Incorporated, Tuscon, AZ.
40. Written by the author in Microsoft QuickBasic with Robix software extensions.
41. Written by the author in Microsoft VisualBasic.
42. Factor analysis routines in Statistica 4.3 for Windows were used to extract eigenvectors with loading greater than 0.6, using varimax normalized rotation.
43. This correlation was based only on clips in which how people felt was consistent with how much they wished to see. In six clips, like "muscles" in Table 3, participants felt good about the clip but did not wish to see more. These inconsistent clips were not included in this analysis. Results of the first 50 and last 46 participants were evaluated separately, which provided 20 clips, minus the 6 inconsistent clips, for a total of 14.
44. Based on prior experience with neural networks, we selected variables that presented visually appealing, linear and nonlinear structure in scatterplots. These variables were based on an examination of all available data; later the training and testing datasets were created by random selection. Using all data to select variables provides the greatest statistical power, but it also introduced weak correlational dependencies among the training and testing datasets. In future studies, the two datasets will be randomly split first, and the predictor variables selected only on the basis of inspection of the training data.
45. We used a commercial backpropagation neural network called "Brainmaker Professional for Windows," version 3.1 (California Scientific Software).Note that taking a "systems approach" can range from the pragmatic, such as use of multifactorial designs and neural network analyses, to the conceptual and analytic, such as viewing problems through the lens of general systems theory of chaos theory. Here we take it to mean a multivariable experimental design analyzed with nonlinear, pattern-recognition techniques.
46. Genetic Training Option for Windows, Version 3.11 (California Scientific Software).
47. Understanding what the neural network learned is difficult because the network essentially carves up a 14 dimensional space to "capture" the relationships between the inputs and output, and it is difficult to visualize more than 3 dimensions.

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