Discussion of Operant conditioning. Funny!

Unedited posts from archives of CSG-L (see INTROCSG.NET):

The following thread on the subject of operant conditioning is
quite entertaining. See also the later discussion ReinforcementTheory.pdf.

[The term EAB stands for Experimental Analysis of Behavior -- the study of
conditions which influence operant behavior]

Date: Wed, 2 Nov 1994 16:38:40 EST
Subject: On Animism

[From Bruce Abbott (941102.1630)]

ON ANIMISM and TRT

Having recently received comments from Bill Powers, Tom Bourbon, and Rick
Marken revisiting the topic of animism, I've decided to have one more try at
an explanation. So here goes.

>Tom Bourbon [941102.1630]:

>   Ouch! I know you are presenting a summary of TRT, but it hurts to see
>   "scientists" savage the language that way. TRT writers portray inanimate
>   objects as agents, imbued with the functional properties of living
>   control systems. I know that way of writing is part of the TRT tradition,
>   but by that practice the TRT community looks downright animistic.

>Bill Powers (941101.0740 MST)]:

>   It's very hard for me to get past this -- pardon me -- animistic
>   language. You have to admit that this sounds as if the reinforcers, the
>   little bits of kibble or the little drops of water, have some ability to
>   initiate an effect on behavior (and now to maintain it), all by
>   themselves. "Alter" and "maintain" are transitive verbs, usually used
>   after the name of an agent capable of causing something. Help me out with
>   this.

>Rick Marken:

>   Hmmm. TRT animistic. Where have I heard that nonsense before? ;-)

You guys are determined to see animalism here, and I'm downright puzzled by
it--in a way. I know your motivation: you are trying to keep the focus on the
causes of behavior that lie inside the organism rather than "out there" in the
environment. Understanding the organism's internal organization is crucial for
making proper sense out of what relationships appear "out there" beyond the
boundary separating organism from environment. However, belief that the
environment "controls" behavior (in the EAB sense of the term) does not make
one an "animist." These folks no more believe in animism than you do.

I've said it before but it evidently bears repeating that for EAB types the
term "control" simply refers to a repeatable relationship between independent
and dependent variables, not to some kind of consciousness that is
"attempting" to accomplish some goal. It is in this sense that, everything
else being constant, ordinary disturbances and changes in the feedback
function (out there in the observable environment) "control" behavior (again,
out there in the observable environment). It is only when you attempt to see
this as "control" of the PCT type (i.e., the idea that the environment as
agent is attempting to bring some perception to a reference level) that
"animism" emerges.

Given your unique interpretation of such ways of speaking, you might want to
accuse physicists, chemists, geologists, meteorologists, aeronautical
engineers, and just about any other scientist or engineer you care to mention
of being "animists," too. To take an example, I hear from some of these folks
that sunspots are controlling weather patterns here on Earth--eeee, guess

those ol' sunspots are havin' a bit of fun with us, huh? Are those guys STUPID or what?

This way of speaking about relationships is quite common in science and engineering, where it rarely if ever results in accusations of animism. By way of demonstrating this fact, I have a challenge for Rick. (I take it that he is working for an aerospace company.) Rick, find an engineer familiar with aerodynamics and ask him or her whether, along with other factors, the angle of an airfoil with respect to the direction of airflow controls the amount of lift generated. Use those exact words (and no more). Then give us an honest report of the reply. I'm willing to bet that the reply will be "yes," possibly with some explanation. If so, accuse this person of being an animist and tell us what reaction you got.

And speaking of animism, what is this "selection OF consequences" I keep hearing about? Who is doing the selecting? [No explanations, please, it's a rhetorical question.] Sounds suspiciously like animism to me...

While mulling over the exchanges brought about by my e. coli "reinforcement" simulations, a strange vision overcame me which I just can't resist sharing with you. Anyway, It's time to lighten up the discussion.

You are watching this week's episode of Star Trek. We are on the bridge of the starship Enterprise, along with her first officers. Captain Kirk is standing on the bridge along side Spock, while Sulu sits at his station, manning the helm. We get a close-up of O'Hura, who is pressing her fingers against an earpiece in her right ear.

O'Hura: "Captain, I'm picking up a signal! It sounds like someone's trying
             to contact us from a great distance, but I can't quite make out
             the language!"

Kirk: "On screen!"

An alien creature appears, leaning over a control console and peering straight into the camera. It speaks.

Alien: "Reinforcement . . .[hiss, crackle] . . . behavior . . .
             strengthened . . . [static, screen flickers momentarily] . . . by
             its consequences! . . . [buzz!] . . . environmental conditions . .
             . established control . . .er . . .ehavior!"

McCoy: "Good lord, Jim, whatever it is it seems to be trying to tell us
             something!"

Kirk: "Spock, what do you make of it?"

Spock: "Judging from what little of its message I was able to piece
             together, it would appear that this creature belongs to a
             primitive form of life such as existed on Earth in the early
             twentieth century. If my calculations are correct, it is a species
             of animist!"

Kirk, swinging into the captain's chair:
             "Well, let's see if we can talk some sense into it! Computer!
             Execute program six-one-five-alpha: the e. coli simulation!
             O'Hura, see if you can lock onto the alien's screen and transfer
             the simulation there!"

O'Hura: "Locking on, captain. Simulation commencing!"

[Camera angle shows view over the alien's shoulder. The alien reaches across the console and begins to manipulate something off-screen. The simulation on the screen freezes, then lines of computer code appear. View switches to the bridge of the Enterprise. Enterprise's main viewscreen flickers, then the e. coli simulation appears there while computer code scrolls up in a window to its right.]

Kirk: "Spock, what's happening?"

Spock, raising his eyebrows:
           "Captain, the alien appears to have launched a simulation of his
           own. He has replaced some of our code. It is different, yet there
           is something oddly familiar about it. I believe it represents some
           kind of control system, although it is not the one we had
           originally intended."

McCoy: "Dammit Jim, now I remember! I've run into something like this
           before! These creatures are psychopaths! You can't make them
           understand ordinary perceptual control theory, no matter how often
           you go over it with them! Next thing you know, this fugitive from
           the twentieth century will be trying to convince us that there is
           some relationship between PCT and that old discredited S-R
           psychology, and just when we're beginning to make headway with the
           Romulans!"

Kirk: "Well I guess I have no choice. Shields up! O'Hura, pass out the
           emergency earplugs! If this alien takes over our intercom system,
           the whole crew could be affected! Sulu, bring her around 180
           degrees! .... Warp 9 on my command! .... NOW!"

[As the distance between the Enterprise and the alien's position grows, the
alien's image flickers, breaks up. The e. coli simulation freezes, then
disappears from the screen. There are no signs of pursuit. Spock turns to Kirk
and speaks.]

Spock: "Captain, it would appear that we have evaded the creature. His
           low technology was no match for the Enterprise."

Kirk: "I wouldn't be so sure. I don't think we've seen the last of him."

Bruce (:->]

Date: Wed, 2 Nov 1994 16:07:24 -0800
Subject: Re: On Animism

[From Rick Marken (941102.1600)] Bruce Abbott (941102.1630) --

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>McCoy: "Dammit Jim, now I remember! I've run into something like this
           before! These creatures are psychopaths! You can't make them
           understand ordinary perceptual control theory, no matter how often
           you go over it with them!

Spock: They are not psychopaths, Scotty. They are just control systems,
           like you and me. That's why we can't make then understand control
           theory. They have to want to understand it on their own. ... Darn
           it! (Sorry, Scotty. That outburst was not logical).

Best Rick

Date: Thu, 3 Nov 1994 12:53:34 -0700
Subject: Star Stuff, Cont'd

[From Bill Powers (941103.1100 MST)]

Atlantis is in orbit. I have to change the predicted launch time in my copy of
STPLUS by +3 minutes. Neat.

Bruce Abbott (941102.1630) continued --

Spock: One moment captain. I have communicated to the aliens that they
           have programmed a control system and they concur. I am going to
           send them another simulation, in which pressing the space bar

causes the E. coli organism to tumble just as before, but now the screen remains blank until the end of the run, when it shows the final position of the spot. I have asked them whether pressing the space bar still controls the movements of the spot. Please stand by ...

[Pause while spot appears on screen, blanks out, then appears in a new position a few seconds later. Spock mind-melds with the console and speaks to the aliens in alienese...]

Spock: Just as I thought, Captain. They say that even though the entity pressing the space bar can't see the movements of the spot, the presses of the space bar still control its position. They say ... one moment.

[Spock converses further with the aliens]

Spock: Captain, they are saying that I described the original simulation incorrectly. Pressing the space bar, they say, is controlled by the changes in spot position. So now they are saying that if we can't see the spot position, it does not control the behavior. Fascinating. Kleebo? [Spock listens] Ah. They are saying that something else must be controlling the behavior in the second simulation.

Kirk: Thank you, Mr. Spock. This is interesting. Can you find any way to show them that the person is controlling the spot? Report.

McCoy: Jim, they've got me half convinced that they're right.

Spock: Possibly, Doctor. Ah, yes. I will send them a simulation in which the movements of the spot are caused by a model of the E. coli system, but the space bar has no effect. So if the person presses the bar, that behavior must be controlled by the spot movements.

McCoy: Hell, Spock, that will prove they're right!

Spock: We shall see. I shall simply send them the simulation and ask them whether it, too, demonstrates control of behavior by the spot.

Uhura: Channel open, sir.

[Spock sends the program and the aliens run it. They run it again. And again. There is a long pause. They run it once more and they finally communicate again at length, in some agitation.]

Spock: As I thought. They have not been able to find a participant who will go through the whole simulation run. The participants begin as they did before, but they soon stop and complain that the apparatus is broken. The spot seems to control behavior at first, but evidently some other contingency comes into play, or perhaps a new discriminative stimulus, or an extinction effect, and participants cease to behave as before. The Lord High Klopno, they say, actually destroyed the keyboard by pounding on it, shouting something that means "Behave, expletive deleted!"

McCoy: Dammit, Spock, you tricked them! That's not fair!

Spock: I am simply subjecting their system of explanation to logical tests. Fairness is a subjective human judgment. Captain, do I have your permission to conduct further tests?

Kirk: Hold on a bit, Spock. I'll have to check this with Starfleet. We may be in danger of violating the Prime Directive here.

[Kirk disappears into ready room, emerging 20 minutes later after the commercials.]

Kirk: Starfleet says to exert extreme caution. This race has been known to launch vicious attacks when cornered. Proceed carefully, Mr. Spock. Condition Yellow.

Spock: Very well, Captain. While you were away I modified the first simulation so that every 14 kneebnits, about 12 Galactic seconds, the program displaces the spot by a small distance toward the bottom of the screen. By their reasoning, this should control the behavior in a way appropriate to the spot's missing the target by about 15 centimeters. Of course we know that the participant will be able to bring the spot to the target as usual. It will be most interesting to see how they explain the result.

McCoy   Well, hell, Spock, it _will_ miss the target, won't it?

Kirk: Dr. McCoy, I know you believe in good old fashioned medicine, but I do wish you would attend Scotty's seminars on control theory. Proceed, Mr. Spock.

Spock: I will transmit the simulation now.

Uhuru: Message acknowledged, sir.

[Very long pause]

Spock: Captain, the aliens say that an important emergency has arisen, and ask if we could continue this conversation later today.

Kirk: Condition Red!

Spock: I do not believe that will be necessary, Captain. They simply need time to consider the results. As Dr. McCoy would say, I believe their hearts are in the right place, which in this case is in their lower thoraxes.

Kirk: Cancel Condition Red. Very well, Mr. Spock, suggest to them that we resume at 20:00 hours.

[Senior officers are again assembled in bridge, after 11 commercials. Spock is mind-melding with the console again. He nods wisely.]

Spock: Yes, that is logical.

McCoy   Dammit, Spock, what did they say?

Spock: They have found an explanation, as I suspected they would. They say that the noncontingent movements of the spot were actually not instances of controlling variations in spot position, but discriminative stimuli which occasioned the momentary shift to a new schedule under which noncontingent spot movements controlled the behavior in such a way as to compensate for the sudden movements of the spot.

McCoy: Shit, they did it.

Kirk: Bones....

Spock: I believe we almost have them, Captain. What I propose to do now is to permanently bias the randomness of the tumbles so they favor a direction away from the target. Now there will be no discriminative stimulus that can be seen, so ....

Kirk: Hold on, hold on, Mr. Spock. We all know what will happen. The subject in the experiment ...

Uhuru: Participant.

Kirk: Thank you, Lieutenant. The participant in the experiment will control the movement as usual and bring the spot to the target.

_We_ know that, Mr. Spock. Every child entering a Federation high-school knows it. Even Starfleet knows it. But this race does not know it. You and I and every officer in Starfleet have taken an oath, Mr. Spock. We have sworn to uphold the Prime Directive, not to interfere in the development of alien races until they have shown themselves capable of assimilating an advanced technology without damage. I must call a halt to this endeavor; you are leading these sentients where they are not ready to go.

Spock: Very well Captain. You are right. What shall I tell them?

Kirk: Tell them that they are right.

McCoy: But cripes, Jim, they _are_ right!

Spock: Very well, Captain.

Kirk: Helm, set course for the Sprague sector, Warp 3. Mr. Spock, the bridge is yours. Dr. McCoy, may I see you in my ready room?

Best, Bill P.

Date: Fri, 4 Nov 1994 13:19:36 EST
Subject: Star Wars

[From Bruce Animist, er, Abbott (941104.1315 EST)]

Bill Powers (941103.1100 MST) --

Pardon me while I dry my eyes. I've been laughing so hard I can't see the screen anymore! Bill, that was GREAT! But while Kirk and crew have been communicating with the aliens, they have contrived to send yet another rather pathetic e. coli simulation of "reinforcement" principles to annoy the Enterprise crew--and just when there was some hope that McCoy could be "deprogrammed."

Of course, my only role in all of this has been that of Starfleet translator. I grew up with the aliens and thus have a more than passing familiarity with their strange language and even stranger conception of the behaving sentient being. Many of them do still appear to believe in the Ptolemaic system of psychology, and I have only been attempting to show how this ancient model may be construed in such a way as to account for planetary movements that we post-Newtonians derive in simpler fashion from first principles. I must confess, however, that this long period of assimilation into alien society has led to certain habits of speech that are difficult to suppress, especially when attempting to describe features of the alien literature, but I shall try my best.

The aliens' new ECOLI3 simulation doesn't quite follow Sam Saunders's proposal, now that I've had a chance to look it over again, because it does not change the tumble rate directly as a function of the consequences of the previous tumble. Rather, it changes tumble rate as a consequence of the current value of dNut. However, the aliens tell me that they recognize this problem and are working on yet another e. coli simulation that works as Sam suggested. They plan to call this new (and I might add, complex) species e. coli skinnerius.

Now, what are we going to do with this nifty CTBASIC control system?

Regards, Bruce

Date: Sat, 5 Nov 1994 08:10:10 -0700
Subject: Observing the aliens

[From Bill Powers (941105.0650 MST)]

Bruce Abbott (941104.1500 EST) --

As Spock would say, "Fascinating." [I misremembered how to spell Spock's name,
or maybe the convention changed during one of our time warps].

These aliens have slippery ways of getting around holes in their arguments.
Notice the construct "the response being targeted for 'reinforcement'". The
use of the passive voice removes any necessity of explaining who or what does
this targeting, and by what means a reinforcement is made to have an affect on
one aspect of behavior rather than another.

Note also the phenomenon of explanation by classification. A positive dNut is
an S+, and a negative dNut is an S-. Merely by virtue of having been
classified, members of these classes "serve to alter the probability of
tumbling". The question of how class membership can "serve" to do this is not
answered, nor is there any explanation of how a probability can be influenced
by class membership, nor of how the _correct_ alteration in probability
appropriate to the classification is made to occur.

Note further the phenomenon of adjusting the premises to suit the observation.
A positive dNut would be actually be classified as an S-, because it must
reduce the probability of Tumbling for dNut to be maintained positive on the
average. But what if it is observed that the real animal behaves to keep dNut
negative on the average? This observation would have effects that cascade back
through the explanation: now the positive dNut would be classified as an S+
because it increases the probability of tumbling, and Nut itself would change
from being an attractant to being a repellent. The classifications are
completely _ad hoc_ and falsification of the explanation is impossible.

Even further, note the prevalence of magical thinking in the explanation.
There is no physical connection between dNut and Tumbling. Instead, it is
merely Tumbling in the _presence_ of the class S+ that increases the
probability of future Tumbling in the presence of S+. This is the essence of
magic, where events occur because of the mere _fact_ of other events: the
demon appears simply because the wizard waves his wand. To be more charitable,
this is pure empiricism, in which one tries to learn the rules of nature
without any grasp of the mechanisms.

When one begins to learn the nature of the mechanisms, rules that once
appeared quite reliable often turn out to be only plausible
misinterpretations. This is the case in the relationship between disturbances
and actions in a control system. The appearance is that the disturbance is
somehow sensed directly by the organism, and that its sensory effects
propagate to the output and cause the motor actions. In our own culture, this
interpretation was given a strong start by Descartes. The existence of an
unsuspected controlled quantity between the disturbance and the organism,
which is discovered only through looking into the mechanisms in detail,
changes this appearance entirely and destroys what had seemed a simple cause-
effect relationship.

The aliens will discover, some day, that the appearance of reinforcers as
causes of behavior is such an illusion. But they are not ready for this
discovery yet. They have not produced their Galileo, much less their
Copernicus, their Kepler, or their Newton. Their world is run by nebulous
abstractions, by rules that apply, or seem to apply, for no reason. They have
more kinship with our own ancient Egyptians and Greeks and our early
theologians than with our modern physical sciences. They have not yet learned
how to make predictions that don't leave loopholes to allow for any
eventuality. Perhaps their experiences with modeling will reveal to them the
difference between a true explanation and a rationalization. We shall have to
wait for them to make that discovery for themselves.

Picard: Computer, end program "Ancient Alien Civilizations".

Best, Bill P.

Date: Mon, 7 Nov 1994 08:23:14 -0700
Subject: A mid-autumn morning's dream

[From Bill Powers (941107.0615 MST)]

You should not encourage people to do silly things. However:

[The Enterprise-D has encountered a distress signal emanating from a small yellowish planet orbiting a sun well on the way to being a brown dwarf. A being of an unfamiliar race appears on screen and speaks to Data, who has the con.]

Being: Greet us. What do you like?

Data: I believe you wish to speak to our Captain.

Being: Good speaking, very good, very good. What do you like?

Data: Do you mean me personally?

Being: Oh, excellent. Better and better. Greet us. What do you like?

Data: Strictly speaking I do not like or dislike anything. But I prefer some things to others; For example, I prefer the color of apples to the color of lemons and the symmetry of lemons to the symmetry of apples. I prefer violin music to the sound of kettledrums. I prefer ....

Being: Well done, well done [whips a violin into view a plays 2 second snatch of Capricioso Aggravato by Salubrious]. Greet us.

Data: [Looks puzzled for a moment, then comprehends]. Ah. Greetings to you from the Starship Enterprise. Do you require assistance?

Being: [Plays a longer segment]. Greet us.

Data: Greetings to you from the Starship enterprise. Do you require assistance? Would you like to speak to our Captain?

Being: [Furiously fiddles for 15 seconds but says nothing].

Data: [Touches com badge] Captain Picard to the bridge, please.

[Picard arrives, is informed of the conversation, and takes the transmission in his ready room.]

Picard: What can we do for you? Are you in need of assistance?

Being: What do you like? Assist us.

Picard: What do I like? I'm not sure I follow you, sir.

Being: [Silence for 15 seconds, then] Assist us. What do you like?

Picard: One moment please. [switches his laptop to hold and goes out onto bridge] Mr. Data, what is this -- person -- talking about?

Data: I have been consulting the records about this planet, sir. It seems to be populated by a group from Earth that was reputed to be extinct some 500 years ago. The people live by controlling each others' behavior, which they do by a social process they call "shaping." If they know what you like, they will offer it to you when you do something that resembles what they want you to do.

Picard: Ah, I see. So we play Twenty Questions with them to find out if
             they need assistance?

Data: That appears to be the case, sir.

[Picard rolls his eyes and disappears, with a sigh, into his ready room.

[It is much later. The Beings have allowed an Ambassador to be beamed aboard
the Enterprise. The Ambassador, fortunately for Picard's sanity, has had some
experience with xenoids and has practiced modes of conversation that they find
more reinforcing].

Amb: .... three million dozen glorf eggs, 24 hundred thousand 1/4 by 20
             machine screws, and last but not least rewarding, 50 billion pints
             of chocolate bleevis milk.

Picard: You demand a great deal, Mr. Ambassador. I doubt that our
             replicator could supply anything like such a volume of goods, not
             to mention the services. Isn't there some reasonable amount of
             assistance that will rescue your people from whatever the present
             emergency is?

Amb: Actually I would do almost anything for a half-pint of chocolate
             milk. But you know how these schedules go. A little dribble here,
             a tiny dab there. If you will sign the agreement, we will of
             course not expect to get everything at once.

Geordi: Excuse me, Captain, Mr. Ambassador, but what IS that thing?

[Picard throws Geordi a grateful glance. A blue ball of fuzz has been floating
during the entire conference just behind the Ambassador's head and a foot
above it.]

Amb: Oh. It's a pet. A BlueFuzzy.

Geordi: It seems able to support itself in the air without any effort. My
             tricorder shows no unusual energy emanations, but it just --
             floats there.

Amb: It has been rewarded for doing so. In fact, it is very well
             trained, if I do say so myself. Observe...

[The Ambassador pulls out a small penlight and flashes it three times. The
blue fuzzball shivers, then splits into two fuzzballs floating side by side.
The Ambassador reaches into his pocket, pulls out two small blue worms, and
give one to each fuzzball.]

Amb: Maintains the behavior, you see, after the discriminative stimulus.

Geordi: That's fantastic. How does it -- I mean they - do that?

Amb: It's just a matter of patience. At first I gave them a worm just
             to come a little nearer to me. Then for obeying the verbal command
             to float in one place. Then to refrain from dividing except when
             presented with three flashes of this light. But watch this -- this
             took a lot of doing, you can believe me:

[Flashes light in a complex on-off sequence, snaps his fingers, and whistles a
note at 500 Hz. The fuzzballs move together, begin to spin around a common
center like a double star, then suddenly merge into the original single
fuzzball. The Ambassador gives it half a worm.]

Data: That is a unique phenomenon, Mr. Ambassador. I do not think I have every
             seen or heard of any organism that splits and then merges again,
             and all while floating in the air without support.

Amb: [Preening]. It's all a matter of scientific technology.

Geordi: Ooooh, I see. It's an artifact. I thought for a minute there that
            it was alive. I suppose you're using some sort of transporter
            technology...

Amb.   Oh, no, no, no. Nothing as crude as that. No, this is a perfectly
            natural organism on our world. But our advanced technology of
            behavior control has brought its floating, dividing, and merging
            behavior completely under our control. We can make it do many
            other things that are seemingly even more astonishing. Some of
            them are illegal, but very enjoyable.

Geordi: Well, sure, I suppose so, but what bugs me is how it's able to do
            those things. What sort of animal is it?

Amb: Actually we breed them now. You have to use a standardized strain to get
            the best results. The real trick is that we keep them at 1% of
            their free-feeding body weight; they'll do anything for a worm. In
            fact, on a variable-interval schedule of one tenth of a worm per
            hour, they will shuttle back and forth between feeding stations
            500 stads apart at three times the speed of light. We fasten
            little messages to them.

Riker: [looks at Geordi] That's nearly Warp 1, isn't it? On one tenth of
            a worm per hour?

Amb: Well, we have to feed them a bit more the rest of the time or they
            die.

Riker: [rousing himself from paralysis] Mr. Ambassador, these creatures -
            - they may be a solution to your shortages. Do you realize that
            they have capabilities of tremendous value that are completely
            unexplainable?

Amb: I just explained them. You start by offering them a worm if they
            move in the right direction. Then you ...

Riker: I mean how they are able to do those things at all. Haven't you
            wondered how they can float there in the air for hours and hours?

Amb: I don't understand. That is the behavior they emit. I have
            explained what makes this one hover, and split, and merge. We use
            the same technology to keep them on their commercial shuttle
            routes. I can see that you are unfamiliar with behavioral
            technology. We pride ourselves, sir, on being highly advanced in
            this regard. If you would just name some act you would like to see
            the BlueFuzzy perform, I guarantee you that within half an hour I
            will have it performing it. I am beginning to see what you mean.
            Captain, do you think there might be a commercial outlet in your
            Federation for services that Bluefuzzies and their trainers could
            perform?

Picard: Oh, yes, I'm sure of it. But I think that my Second Officer was
            raising a different point. Somehow these creatures are performing
            actions that we could only simulate on a holodeck, and are doing
            them with an incredibly small amount of energy. I am sure that the
            Federation would consider some rather substantial grants if you
            were to allow us to study these creature, without harming them I
            assure you, to see how they are able to do these things.

Amb: [In conflict]. Well, all this strikes me as crass reductionism.
            The point isn't how they do it, but that we can train them very
            quickly and efficiently to do anything we want them to do. I could
            do the same thing to control your crewmen, you know. Just tell me
            what they like and pretty soon I'll have them eating out of my
            hand. I'll be happy to handle any personnel problems, if you could
            just see your way clear to releasing a few hundred cartons of
            chocolate ...

Troi: We have no personnel problems.

Amb: Just tell me what you want, Captain, I'll do anything. It's been
            ages since we ran out of chocolate bleevis milk. My children are
            out of control. My wife is out of control. So is my husband.
            [Begins tapping on the table].

Picard: Well, Mr. Ambassador, we will certainly take your requests under
            advisement.

[Ambassador taps faster and faster, on the table, his knees, his other knees,
the arm of the chair, Counsellor Troi's head...]

Picard: Oh, for God's sake. Mr. Data, will you please look up the
            replicator code for choc ...

Data: On my way, sir.

Ricker: I'll come with you.

Troi: Hurry back.

Picard: Computer, tea, Earl Gray, hot. Mr. Ambassador, have you tried this
            drink? It's really quite delicious and invigorating .... here, let
            me hold it for you...

Best, Bill P.

Date: Mon, 7 Nov 1994 10:04:29 EST
Subject: ECOLI4: The Aliens Capitualte

[Bruce Abbott (941104.1000 EST)]

>>[From Bruce Abbott (941104.2020 EST)]

>Rick Marken (941104.1400)

>   Tell the aliens that ECOLI4 still contains no reinforcement. The stimulus
     effects just go back one extra trial. That is, the change in response
     probability depends on the current input (dNut) and the prior input
     (NutSave) but there is no differential change in the probability of the
     response depending on what response was actually made after the prior
     stimulus - - ie. there is no reinforcement. Because there is no
     reinforcement, E. coli still does its biased random walk to the target;
     that is, it controls.

>>   I have consulted with the aliens, and they refuse to accept your
     analysis.

There has been a new development. Here, let's tune in--the last episode of
Star Trek, The Final Solution is in progress.....

[We are once again on the bridge of the Enterprise. On the main viewscreen,
the alien creature from the previous episode appears.]

Spock: Captain, I have programmed the ship's computer to translate the
            alien's language.

Kirk: Put him on.

Alien: Greetings, Enterprise. We had no sooner transmitted our last
            message when we became aware of a fatal oversight in our ECOLI4
            simulation; perhaps it is the flaw to which your first officer
            alluded in his as-yet-unreceived message. In converting ECOLI3 to
            ECOLI4, our simulation engineer had overlooked the code that
            integrates dNut over timecycles. Thus we were under the false
            impression that there was no carryover of dNut from pre- to
            postreinforcement time. Given this false belief, it seemed that
            the simulation was proof of principle. We were in error.

When we removed the dNut carryover, our simulation began to behave exactly as you specified it should.

Spock: It is only logical.

Alien: Yes, we see that now. Apparently we are suffering from having made too many trips through the transporter room. We now realize, as your Mr. Spock pointed out, that there is no way for reinforcement to operate on the tumbling response. This had been our initial conjecture, but we had come to believe that the three- term contingency would provide a solution. Having seen the result of our own corrected simulation, we now know that it does not, and why. You had tried to explain it to us, but there was interference in the hyperspace channel and we were not able to completely decode your message.

Spock: As you are doubtless now aware, the consequences of tumbling are as likely to produce negative as positive dNut, regardless of the conditions existing prior to the tumble. Thus there can be no systematic change in $p(\text{Tumble}|S+)$ or $p(\text{Tumble}|S-)$.

Alien: Correct, as usual. And that is why, in our initial simulation, we chose to work with the consequences of forward motion rather than with the consequences of tumbling. At that time we recognized that tumbling could not be the response on which reinforcement would operate. Reinforcement can produce consistent changes in response probabilities only when the consequences of the response are reasonably consistent. But tumbling's consequences are completely inconsistent. It was your insistence that we attempt to model reinforcement of TUMBLING that led us to thinking that the addition of discriminative stimuli might provide this consistency. We now see that it does not.

Spock: Then you agree that the "three-term contingency" of which you spoke does not work.

Alien: Yes, not when tumbling is modeled as the response on which reinforcement acts. However, our mistaken simulation with dNut carryover does nicely illustrate how a control system can learn to develop and maintain a negative feedback relationship between tumble rate and dNut. We take it that this is not a feature of your own e. coli simulation, although we have no doubt that you could have provided it had you wished to do so.

Kirk: So what do you propose as the next step?

Alien: As we indicated in our previous communication, we will modify our simulation so that it explicitly models a feedback-regulated control system that is able to learn appropriate behavior that will keep its perceptions close to its internal reference level.

Kirk, turning to Spock:
              Perhaps there is hope yet for this species, don't you think?

Spock: We shall see, captain, we shall see.

Cheers, Bruce