

The potential anomalous component of Intuition Empirical evidence and an integrated theoretical approach¹

Dick J. Bierman, University of Amsterdam

Introduction

Two words in the title deserve some explanation. First the word 'potential' in 'potential anomalous component'. Before one can call a phenomenon anomalous, which is an extraordinary claim, one needs to have extraordinary evidence. Although there is cumulating evidence I do not think we are in the position to say we are sure that there is an anomalous component in intuition. But we have enough data supporting that hypothesis to explore potential theoretical explanations.

The second reason to call the phenomena potentially anomalous is that it is my intention to show that physics is able to accommodate these phenomena without any alteration to physics. So they wouldn't be anomalous because they would fit in present day physics.

The second word in the title that needs some elaboration is the word 'integrated' in 'integrated theoretical approach'. I strongly believe that we should integrate the study of anomalous phenomena with main-stream science. Not only by using similar experimental paradigms that allow for the study of normal and paranormal aspects in a single experiment but also when trying to develop a theoretical framework.

I therefore will start with a main-stream qualitative model of intuition. It will be illustrated by the famous gambling experiment that originally was done by the research group of Antonio Damasio.

Then I'll argue that this model can be extended to accommodate the anomalous component of intuition, if any, that has been labeled by the word 'presentiment'. That theoretical extension supposes a violation of causality.

It should be remarked that violation of causality cannot only account for say presentiment effects but actually for all 'paranormal' phenomena: telepathy, clairvoyance, precognition and psycho-kinesis.

I will argue that, contrary to common belief, physics can accommodate this violation of causality. This will be done explaining the status of time-symmetry in physics and it will be argued that time-symmetry is generally not observed in physical systems because the boundary conditions do prohibit this. However time symmetry occurs in relation with highly coherent systems like our brain while producing unified consciousness.

¹ This manuscript is not an article but a report of the oral contribution at the symposium. It therefore does not follow the conventions that are generally valid for articles. The figures are snapshots of the powerpoint slides. There are no references and experimental procedures are not described in detail. However much detail and almost all references can be found in: Bierman, D. J.(2008). Consciousness induced restoration of time-symmetry. A psychophysical theoretical perspective. *Conference proceedings of the 51st Convention of the Parapsychological Association*. Winchester, UK. (also available at: <http://m0134.fmg.uva.nl/publications/2008>)

Result of a recent experiment will be presented in order to support this claim. This particular experiment shows signs of causality violation in a non emotional setting: the observation of a so-called Necker cube.

Finally individual differences will be discussed in this theoretical approach equating brain coherence with the coherence needed to observe time-symmetry and this is illustrated by some data of a meditation study of presentiment.

A main stream model for intuition: the somatic marker

Imagine that a chess player is considering what move to make. There are a number of options to choose from. Naively we think that the chess player is quite good in analysis and that a deep analysis results in a choice. From thinking aloud protocols we learned that the analyses is preceded by another process.

In the past the chess player has played hundreds and studied thousands of games. In many of those there have been similar positions on the board. And he has experienced the outcome of many different possible moves. A number of those moves were clearly winning, others resulted in loss. Good or bad outcomes. So some emotional marking has taken place. Most of this information is probably not accessible by explicit searching through memory. But it is assumed that it is learned implicitly. So the first part of the model assumes that implicit learning has occurred where the potential moves space have been marked with positive or negative affect. The model then assumes that in the case of a similar position on the board this implicit knowledge is activated and also the associated emotional labeling. Emotions are associated with bodily sensations. So when a solution pops up the relevant somatic sensation might be felt. But actually we assume these negatively labeled moves are already excluded non-consciously. So basically this process results in a number of moves that haven't been labeled as bad moves. Now the analytic conscious processing is limited to the reduced set of possible moves that had no negative consequences in the past. Calculations can now begin. (see figure 1)

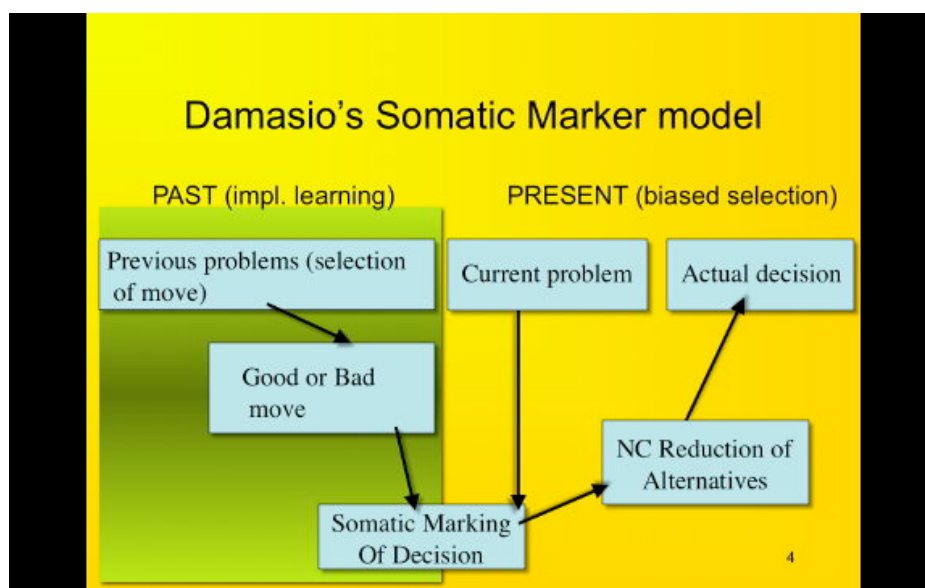


Figure 1: Schematic of Damasio's Somatic Marker model

If one asks the chess player why he didn't calculate another, at first sight reasonable, move, he might answer that it doesn't feel good. If one keeps asking he might in the end remember that in a game between Botvinnik & Aljechin in 1932 this move turned out to be disastrous.

The big advantage of the non-conscious filtering is that it can occur in parallel, the biggest disadvantage is that it might fail.

A long time ago I talked with Smislov a former chess champion. At the time he was already old but still played at grandmaster-level. He told me that he had stopped the calculating part and played just on his feelings or intuition.

The gambling experiment

This Somatic Marker model is claimed to be supported by gambling experiments of the Damasio group. In these experiments there are 4 decks of cards. Unknown to the subjects 2 of those decks are disadvantageous and the other 2 are advantageous. The task of the subject is to take cards of any of these decks. They know nothing about the decks. They have to gamble, for them this is just a gambling experiment.

The participants start with 2000 in artificial money. They take then a card from 1 of the 4 decks, turn the card around and see the backside on which is indicated the amount of money they win or lose.

During the whole task the skin conductance is measured. Skin conductance correlates with the state of arousal. There are three periods in a trial. First the subject prepares to take a card, then he takes the card, then the card is turned around and on the backside there is feedback in terms of a monetary reward or punishment. (see figure 2, lower panel)

Damasio used two groups of participants. One group consisted of patients with specific brain damage that didn't affect their intelligence.

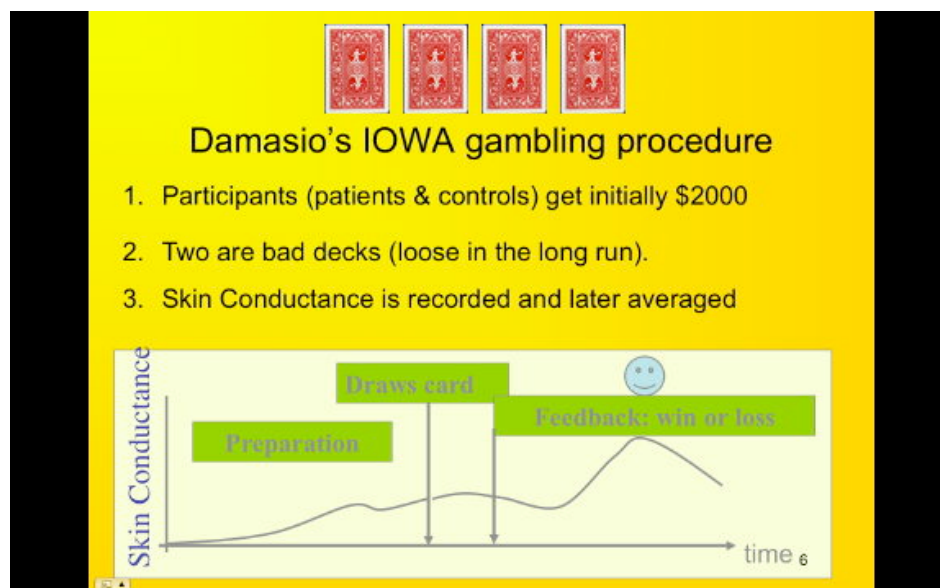


Figure 2: Major aspects of the IOWA gambling task and an example of the skin conductance during one trial.

What was found was not only that normal subjects take more often from good decks than from bad decks even when they were claiming that were choosing randomly but also that in the preparation phase, just preceding taking a card from the bad decks, the skin conductance increased compared with just before taking a card from the good decks. This effect in skin conductance was absent in the patients. In normal subjects skin conductance produced a kind of a warning signal that was called the somatic marker. So in this experiment implicit learning as well as somatic marking occurred. That was Damasio's interpretation.

There has been strong criticism on Damasio's experiments and on the interpretation thereof. However in our own research using pupil dilation rather than skin conductance we found support for this model and we have observed that when looking at an bad alternative and having an increase in pupil dilation resulted in not choosing that alternative, indicating that indeed the somatic marker had an impact on the (intuitive) decision.

The gambling experiment revisited.

We have heard in several contributions to this symposium that an anomalous effect called 'presentiment' might play a role in situations where one has a future emotion. Can we extend the somatic marker model in such a way that this phenomenon is integrated?

That is possible indeed by extending the model into the future.

A part from the past experience that drives a decision in Damasio's model it is the future experience that drives the current bodily process reflected in for instance the skin conductance in the extension. But this increased explanatory power of the extended model comes at first sight at a high price as can be seen in figure 3.

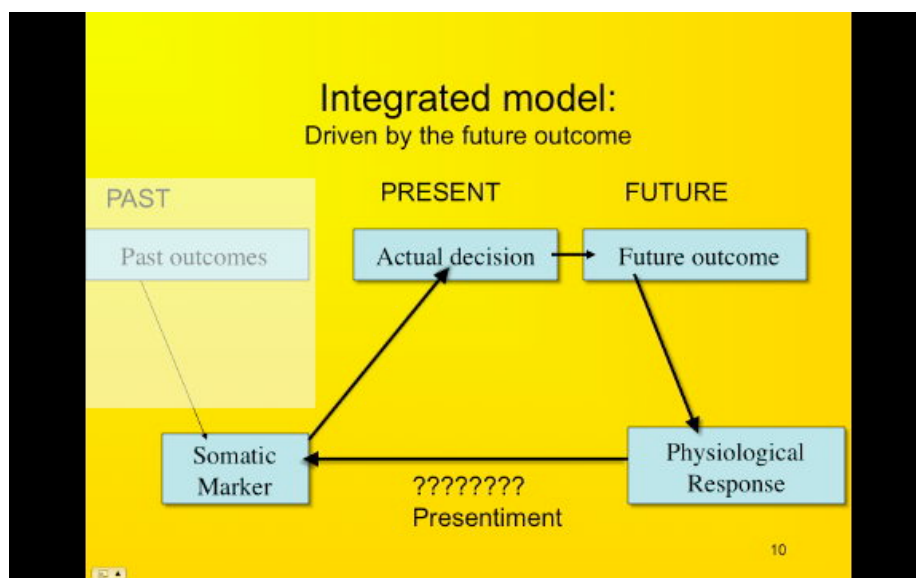


Figure 3: The extended SM model

The future outcome of a decision creates a bodily response that then becomes also a source for the decision or the physiology when the decision is made. So there is a kind of symmetry between future and past.

The price is that this model contains an arrow that runs against the normal time. And at first sight this looks like a revolutionary, nay impossible, step. Could there be final causality (as it been called by the greek philosophers).

Here is the naïve response to such a proposal: Of course this is impossible. It undermines the whole scientific building. Because all scientific models (except some parts of QP) seem to be formulated in terms of cause and effect where cause precedes the effects.

So if one proposes such a revolution one has also to present overwhelming evidence. Let me say that I don't believe we are there yet. And there might be good reasons that it is difficult to get there. Not the least one is that a causal effect from the future might result in paradoxes (as you can see in the closed loop of arrows) and these paradoxes should be avoided when one proposes a theory.

However there is accumulating empirical evidence for this anomaly and ...interestingly we might use the results of Damasio's own gambling experiment to find evidence for presentiment!!

In order to understand this we should have a look at the procedure that is generally used in presentiment experiments. First of all there should be a random event in the future with two possible outcomes. One of those should be a positive or neutral the other negative. This is exactly what is happening in the gambling experiment because the actual result of taking a card from whatever deck is winning or losing. Damasio averaged all skin conductance in the preparation period over bad decks and over good decks and then compared these two averages. Rather than averaging per type of deck we average for all decks per type of outcome: winning or losing.

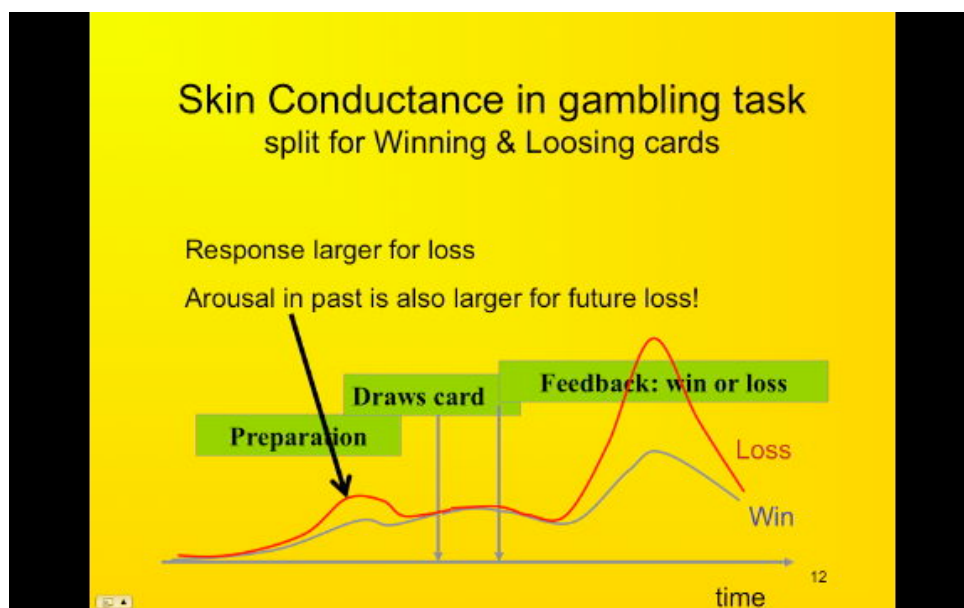


Figure 4: an illustration of the average time course of skin conductance preceding taking a losing and before taking a winning card.

The results of this re-analysis turn out to be marginally significant (see figure 5) and I should note warn that the randomization that Damasio used was inferior to what is custom in psi research. But for the sake of argument let us assume that presentiment is real and hence we have to deal with some apparent violation of causality.

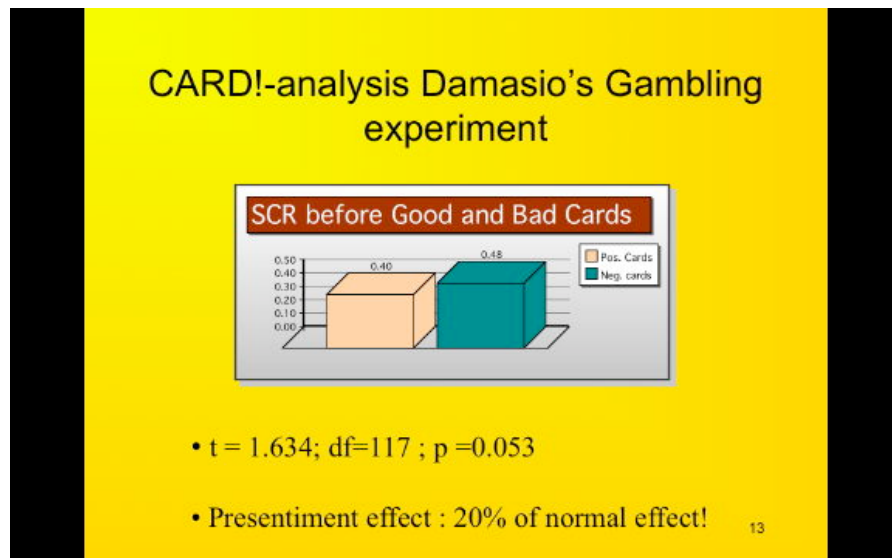


Figure 5: Results of re-analysis of the IOWA gambling task

All paranormal effects 'explained'

The traditional causal telepathy model that was formulated was a 'third eye' (or a sixth sense) scanning all the information in the world and selecting what was relevant for the organism. This is a daunting task if one has limited information processing capacity as we humans do. However in the extension to Damasio's main stream model, that is discussed here, the computational demands are very limited.

Rather than scanning all information in the cosmos, telepathy only occurs because in the future there will be feedback which then reflects into the present backwards in time. In this way the computational demand issue is solved because processing is limited to future events. In fact there is no computational demand other than that for processing the feedback. Actually the whole idea that we have some kind of mysterious information transfer, an idea that is still hold strongly in the community of psi researchers, is invalid.

The same arguments hold for other psi phenomena, like clairvoyance and of course precognition.

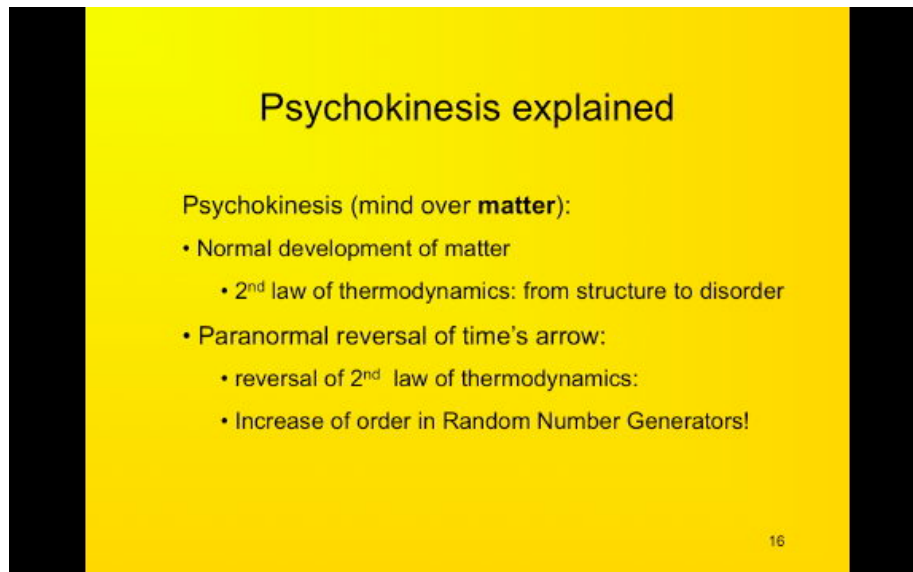


Figure 6: Fitting PK in a model with time-symmetry

Psychokinesis seems, at first sight, difficult to account for. However in physics a reversal of the arrow of time results in increase of order, a random number generator becomes non random. And that is exactly what happens in (micro) PK experiments. In fact on an abstract level psi effects can be seen as correlations and correlations do result in more structure, in that sense a telepathy experiment measures a structure (correlation) that seems not to have an underlying 'cause'.

Can physics accomodate psi phenomena?

The obvious objection to this model is that it is theoretically impossible. And when this is said what is actually meant is that physics doesn't allow this 'time running backwards'.

However this is not true. The reason is that most of physics is inherently time-symmetric. What does that mean?


Well let's have a look at Maxwell's theory of EM. This theory boils down to a set of (differential) equations. These equations have to be solved for specific cases. The specific case is defined by *initial* and *boundary* conditions.

It turns out there is not a single solution for these set of equations, there are TWO solutions. One is called the retarded solution, the other is called the *advanced* solution. In the advanced solution 'time is running backwards'.

Most physicists think that this is a quirk of the mathematics that have been used. They claim that they never observe the advanced solution in their physical experiments. So it doesn't exist. However a number of famous theoretical physicists do not agree and have treated these advanced waves as a real entity (see figure 7).

Time's arrow in physics: the facts

- In nearly all physical formalisms: time-symmetry
 - Most notably in Electro Magnetic theory:
 - Retarded and **Advanced** solution
- Is generally considered a quirk of the mathematics
(notable exceptions: Feynman, Wheeler, Cramer)



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Figure 7: Physical formalisms are time-symmetric

Now the hypothesis that we have proposed is as follows:

The fact that advanced solutions do not occur in simple physical systems is due to the simplicity of the boundary conditions. However if there is a brain involved, and especially a brain that is sustaining consciousness, we do have extremely complex boundary conditions. We have physical theories for the extremely small, the extremely large, we propose that for the extremely complex, the boundary conditions are such that advanced waves become a real solution.

The hypothesis further holds that the system not only should be complex but also in an extremely coherent state: The more coherent the information absorbing system like our brains, the stronger the contribution of the advanced solution. Within this model, individual differences therefore may be accounted for by differences in the coherence of the brain states.

In main stream consciousness research one of the issues is the so-called binding problem: How is it possible that all these separate information processes do result in a unified experience: This unification requires some form of binding and hence some form of coherence. In treating advanced waves Feynman and Wheeler suggested that coherent systems play a significant role. We are not claiming that we are dealing with the form of coherence that Feynman and Wheeler were talking about but use their treatment as a metaphor to support our search for an underlying factor that can account for individual differences.

One could wonder if there are ways to test this proposition.

The crucial point is that physics can accommodate time reversal in the form of time symmetry but why should that only occur when emotion is involved as is the case in for instance the gambling experiment?

Of course emotions might play a role by their stronger future responses. But in principle these time-symmetry effects should also occur in non emotional situations.

The Necker cube experiment

If we present a transparent view of the cube on a screen an interesting phenomenon occurs: Participants experience the cube from above (top-view) for some time and then it switches spontaneously in a view from the bottom (bottom-view). So nothing changes on the screen but something changes in the experience of the viewer. You can try it yourself. This is called a bistable percept (see figure 8)

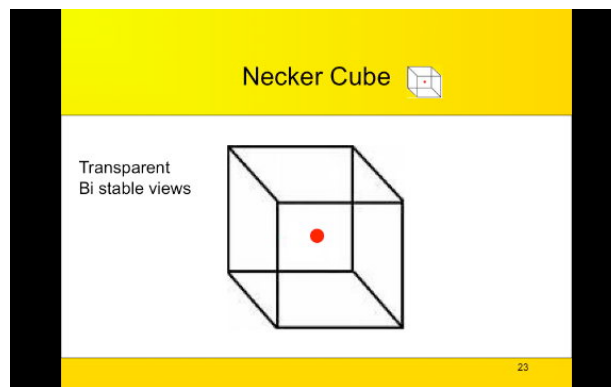


Figure 8: A Necker Cube

There is a lot of literature on why and how this happens but that is not relevant for our experiment, not yet.

The subject has to wait for some time. He might experience a few switches from top-view to bottom-view and vice versa. Then at some point the subject has to press a button when a switch from bottom to top view occurs. And then he has to press the button again when the next switching back occurs. So what we measure is the time that the top view is experienced.

And now comes the manipulation. As soon as the computer has registered this duration of the top view perspective it presents a *non transparent* view of the cube (see figure 9), randomly the top-view or the bottom-view.

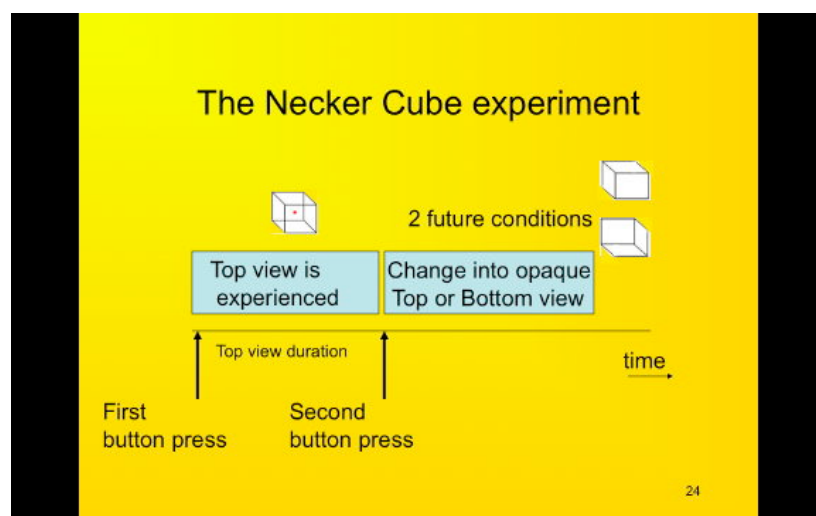


Figure 9: two conditions in the Necker Cube experiment.

According to normal causality this manipulation should have no effect on the already measured top-view duration.

However it has. In two independent experiments, one at the University of Groningen and one at the university of Amsterdam there is a combined mean difference of this top view duration of 129 milliseconds due to the two future conditions (see figure 10).

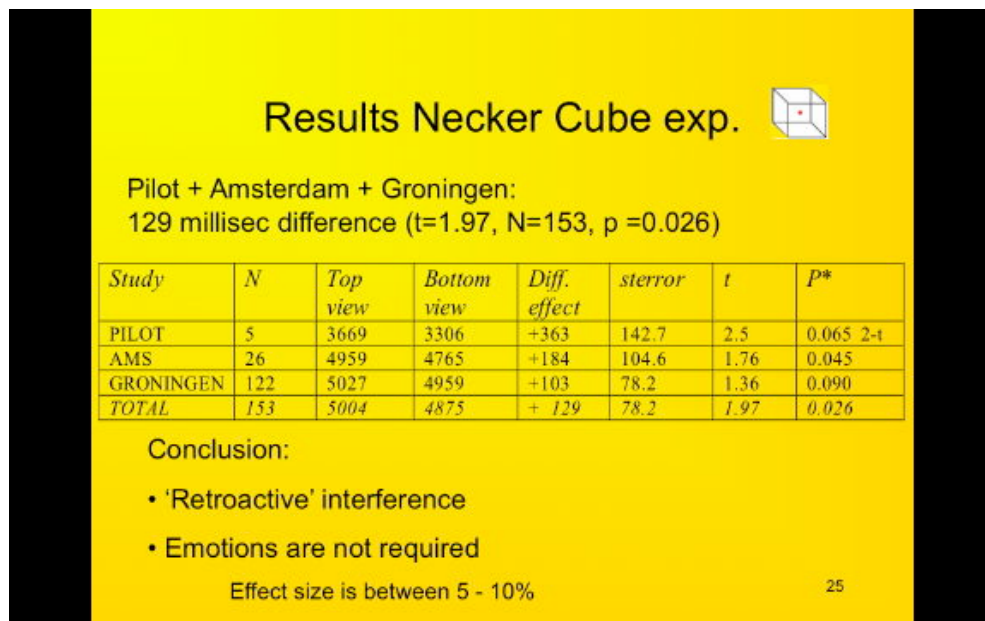


Figure 10: Results of the Necker Cube experiment

We can only explain this if we assume a violation of causality. Rather than calling this presentiment one could call this retroactive interference. This adds to the growing number of retroactive paradigms like retroactive habituation and retroactive priming.

And apparently these effects occur in non emotional context. Emotions are not required. The effect size is the magnitude of the anomalous differential effect divided by the normal effect mean switch duration. This effect size seems to be a bit smaller than those obtained in presentiment experiments. So emotions may play a role.

Individual differences

As usual in behavioral experiments there are strong individual differences. some participants don't show the effect others show a much stronger effect. Partly this is due to uncontrolled variables for instance in noise of the vigilance of the subjects. In the model there is only one variable that explicitly might explain individual differences, namely the coherence of the brain state of the subject. This concept has different operationalizations in neurophysiology, these might be different from the concept as it is defined in physics. However for the sake of exploration we assume that long time meditation produces a more coherent brain state. Thus it makes sense to compare meditators with a control

group. That is exactly what we did in a fMRI study where we used the standard presentiment paradigm with neutral and emotional pictures. The most striking result is given in figure 11. The dependent variable is the number of anticipatory peaks when we average the BOLD signal per subject separate for the three conditions (violent, erotic or neutral pictures)

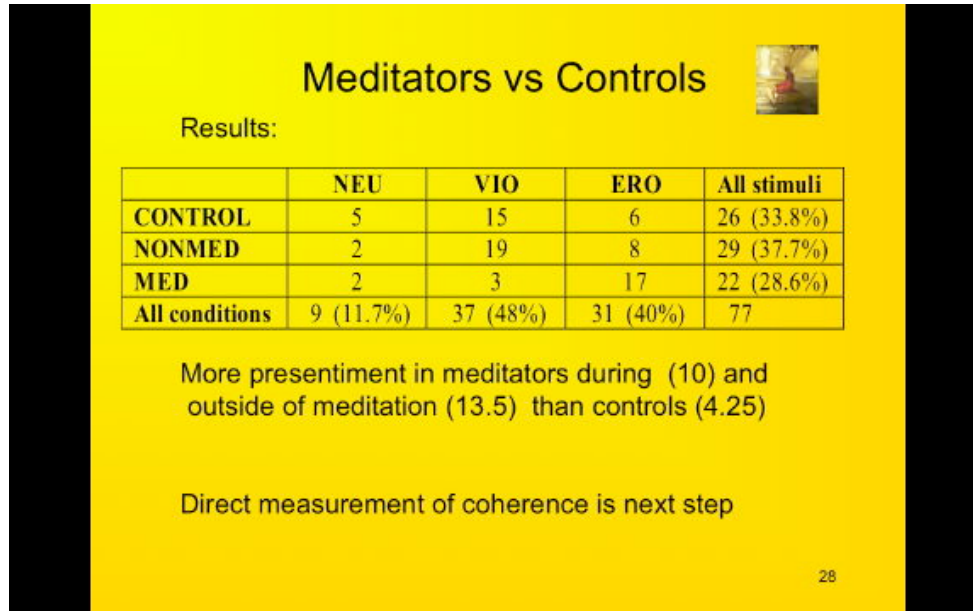


Figure 11: Results of the fMRI – meditator experiment

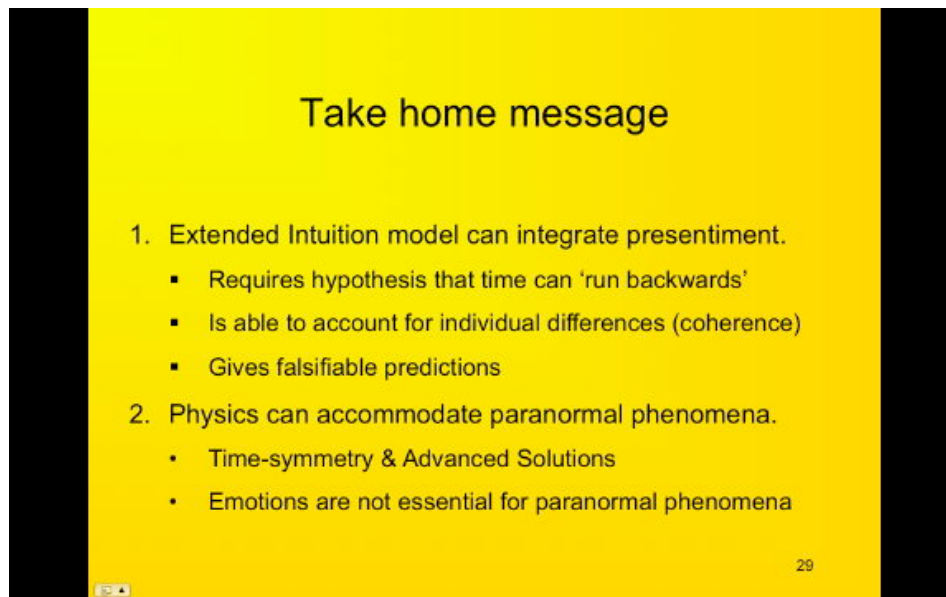
In both groups, meditators and matched controls, we found evidence for presentiment effects. I.e. there were more subjects with an anticipatory peak preceding the emotional pictures than preceding the neutral picture. However the effect was much stronger for the subjects that had a long meditation experience. There was an interesting internal effect with regard to the type of emotional picture and the type of actual brain state. If we asked the meditators to actually meditate in the scanner they had more ‘presentiment’ for the erotic stimuli. While, if they were in a resting state in the scanner, the ‘presentiment’ effect was strongest before the violent pictures. We should mention that the meditators had a long training to be able to meditate in the scanner and all did indeed two session, one while meditating, one in resting state (in counterbalanced order)

We did ASSUME here that meditation results in more coherent brain states. The next step would be to measure that coherence directly rather than to assume something about it.

There are more ways to test the model that I have discussed here. For instance the ‘form’ of the anticipation should in some way correlate with the form of the response. This might be amplitude or other more complex aspects.

Conclusion

What we have tried to demonstrate in this presentation is that the integration the study of anomalous phenomena with main stream research questions and theories results in useful research program, as well in empirical terms as in theoretical.



Take home message

1. Extended Intuition model can integrate presentiment.
 - Requires hypothesis that time can 'run backwards'
 - Is able to account for individual differences (coherence)
 - Gives falsifiable predictions
2. Physics can accommodate paranormal phenomena.
 - Time-symmetry & Advanced Solutions
 - Emotions are not essential for paranormal phenomena

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Figure 12: Review of conclusions

The domain of intuition research is obviously a very suitable domain to try this research strategy. However other domains are possible. For instance 'placebo research'.

The current approach might seem disappointing for those that feel that anomalous effects show that there are things that are not accessible for the scientific method. Time-symmetry indeed is extremely difficult to grasp conceptually. It is even unclear if time-symmetry really violates causality. It is felt that by further mathematical formalization, the meaning of these phenomena might eventually become obvious.