

# Evidence and the Demands of Rigor

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*For Pat Suppes*

# Two lessons

- Rigor matters.
- Don't bring to a subject more rigor than it can bear.



# Topic

A place where rigor is badly needed  
and I am in trouble for trying to bring it  
there....

...the movement that insists that RCTs  
are the gold standard in evidence for  
predicting medical and social policy  
effectiveness.



# Who am I in trouble with?



Sir Iain Chalmers



Sir Michael Rawlins



# Question

What makes

E: T has a positive effect size for O in an ideal RCT (there)

evidence that

H: T will play a positive causal role for O if implemented here?

**What connects E with H?**



# Answer

Concatenation of two arguments:

- **The RCT Argument:** uses the premise E: ‘the effect size of T for O is positive in an ideal RCT’ to conclude H’: ‘T plays a positive causal role under the principles governing O in the study’.
- **The Effectiveness Argument:** uses the premise H’: ‘T plays a positive causal role under the principles governing O in the study’ to conclude H: ‘T will play a positive causal role here’.



# Effect Size

$$\langle ES \rangle =_{df} \langle O(u)/T(u)=x \rangle - \langle O(u)/T(u)=x' \rangle$$

ES = difference between the average of O in the study group and the average of O in the control group.

- **SO WHAT?**

Suppose for simplicity that causal principles are linear. So O outcomes in the study are determined by a causal principle of the form:

$$CP: O(u) = \alpha(u) + \beta(u)T(u) + W(u).$$



$$\begin{aligned}
\langle ES \rangle &=_{df} \langle O(u)/T(u)=x \rangle - \langle O(u)/T(u)=x' \rangle \\
&= \langle \alpha(u)/T(u) = x \rangle - \langle \alpha(u)/T(u) = x' \rangle + \\
&\quad \langle \beta(u)/T(u) = x \rangle x - \langle \beta(u)/T(u) = x' \rangle x' + \\
&\quad \langle W(u)/T(u) = x \rangle - \langle W(u)/T(u) = x' \rangle.
\end{aligned}$$

Random assignment of  $u$ 's to  $x$  and  $x'$   $\rightarrow$  for  $u$ 's in the study,  $T$  is probabilistically independent of  $\alpha, \beta, W$ . So

$$ES = \langle \beta(u) \rangle (x - x').$$

Recall CP:  $O(u) = \alpha(u) + \beta(u)T(u) + W(u)$ .

So  $ES > 0 \rightarrow \langle \beta(u) \rangle > 0 \rightarrow T$  appears in CP.



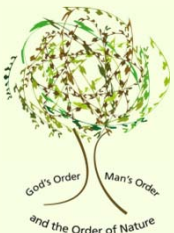


$$(ES) = av(O)_T - av(O)_C \quad CP: O(u) = \alpha(u) + \beta(u)T(u) + W(u)$$

## *RCT Argument*

1. The study satisfies condition  $\alpha$ .
2. The study satisfies condition  $\beta$ .
3. The study satisfies condition  $\gamma$ .
4.  $ES > 0$  in the study.

*Therefore  $H'$* : T plays a positive causal role in the study (=df T appears in the causal principle governing O in the study and  $\langle \beta(u) \rangle > 0$  there).



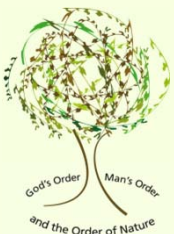
- We have a good argument, *RCT*, that has among its **premises** the evidence claim
  - E =df ‘The effect size of T for O in a well-conducted RCT (there) is positive’and has as its **conclusion**
  - H’ =df ‘T plays a positive causal role under the principles governing O there.’
- To establish E’s evidential relevance to prediction H, we need a good argument – the **Effectiveness Argument** – in which H’ figures essentially as a premise and H as conclusion.



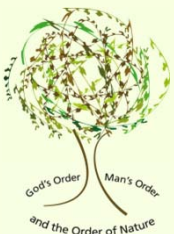
$$\text{CP: } O(u) = \alpha(u) + \beta(u)T(u) + W(u)$$

This formulation can be misleading.

- $\beta(u)$  is not a constant.
- Causes are INUS conditions for contributions to  $O$ .
- $T$  operates as part of a team, in cooperation with a set of helping factors.
  - These are represented in one fell swoop by  $\beta(u)$ .



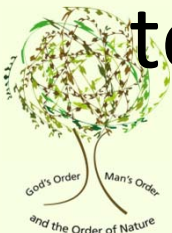
- $ES > 0$  in a population shows the **average** of  $\beta(u) > 0$  in that population.
- Recall Suppes's probabilistic theory of causality which looks for probabilistic dependence between T and O in different subpopulations, characterized by different values of  $\beta$ .



T plays a positive causal role here →

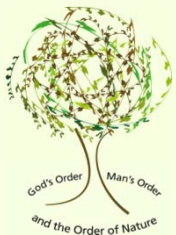
- T appears in the causal principles governing O here.
- There is a 'good' distribution of the helping factors for T here.

NB. These are the helping factors necessary for T to operate *here*, which are often different than those required for it to operate *there*.



# Effectiveness Argument

1. T appears in the causal principles governing O in the study [from  $H'$ : T plays a positive causal role in the study].
2. If T appears in the principles for O there, it does so here.
3. The support factors necessary for T to contribute to O under the causal principles that hold here are X,Y, Z.
4. We have a 'good' distribution of X,Y,Z here.



Therefore H: T will play a positive causal role for O here.

# Here's why they are mad at me

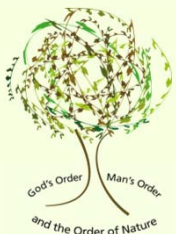
T will play a positive causal role here

T plays a positive causal role there

$\langle \beta \rangle > 0$  in RCT

Eff  
Arg't

RCT  
Arg't



# T will play a positive causal role here

The helping factors for T are X,Y,Z

We have a good dist'n of X,Y,Z here

T appears in the CP for O here

?

?

?

?

?

?

?

T appears here → T appears there

T appears in the CP for O there (and there)

?

?

R  
C  
T

R  
C  
T





# The missing premises may be true...

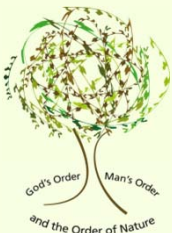
- Often
- Seldom
- Sometimes

What matters for predictions about here is that

**They be true for here.**

And **we must have warrant for that.**

Otherwise the RCT result is no support at all...



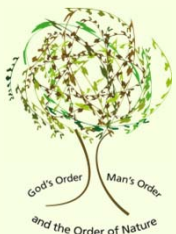
T will play a positive causal role here

T appears in the CP  
for O here

T appears in the CP  
for O there (and  
there)

R  
C  
T

R  
C  
T



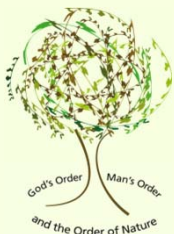
# In conclusion

- I thank Pat for his lifelong dedication to demanding rigor where it is needed.
- And I shall, trying as always to follow Pat's good model, keep up this demand with Chalmers and Rawlins.
- Because they are building their predictions on very shaky foundations.



# Why we need rigor for effectiveness

Performance on a poor foundation.....



Thank you!

