Why There Isn’t Inter-Level Causation in Mechanisms

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The Puzzle

Mechanistic View
(Mutual Manipulability Account)

Manipulationist View of Causation

Incoherence of Inter-Level Causation

Are these three inconsistent?

I argue that the tension is merely apparent.

Outline

1. Mechanistic Explanation
2. Manipulationist Causation
3. Is There Inter-Level Causation?
4. **Dissolving the Problem**
   - Mechanisms in Causal Graphs
   - Fat-handed Interventions
5. **Argument Against Interlevel Causation**

Mechanistic Explanation

What is a Mechanism?

Structure + Function: “entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions” (Machamer, Darden, and Craver, 2000)

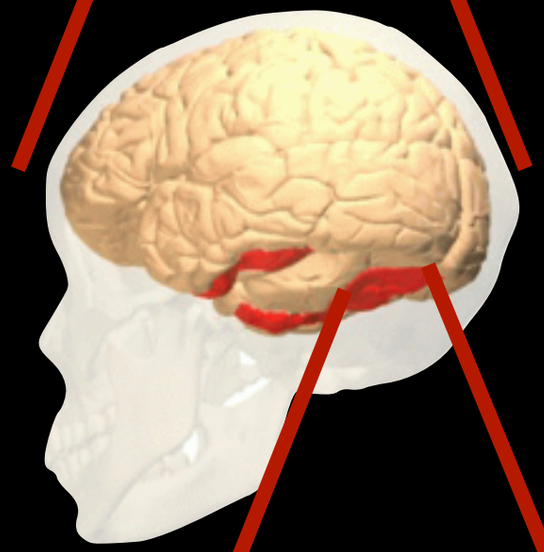
Causal Structures: Entities have specific roles and interact causally with other entities. (Craver, 2007)

Multi-level Structures: Entities are composed by other entities, and are organized spatially and hierarchically (Wimsatt, 1976; Bechtel 2006)

Mechanistic Explanation

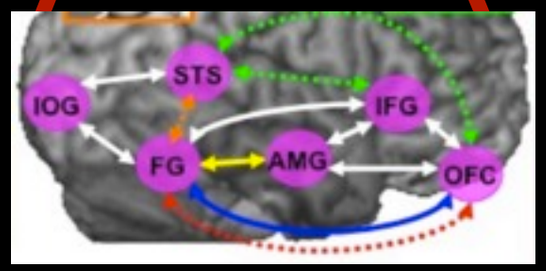
Example: Study of Face Recognition

Psychological studies of performance in face recognition.



Studies involving the fusiform gyrus (imaging, lesions)

Activity of cells in a specific cortical network



Mechanistic Explanation

Levels of Mechanisms

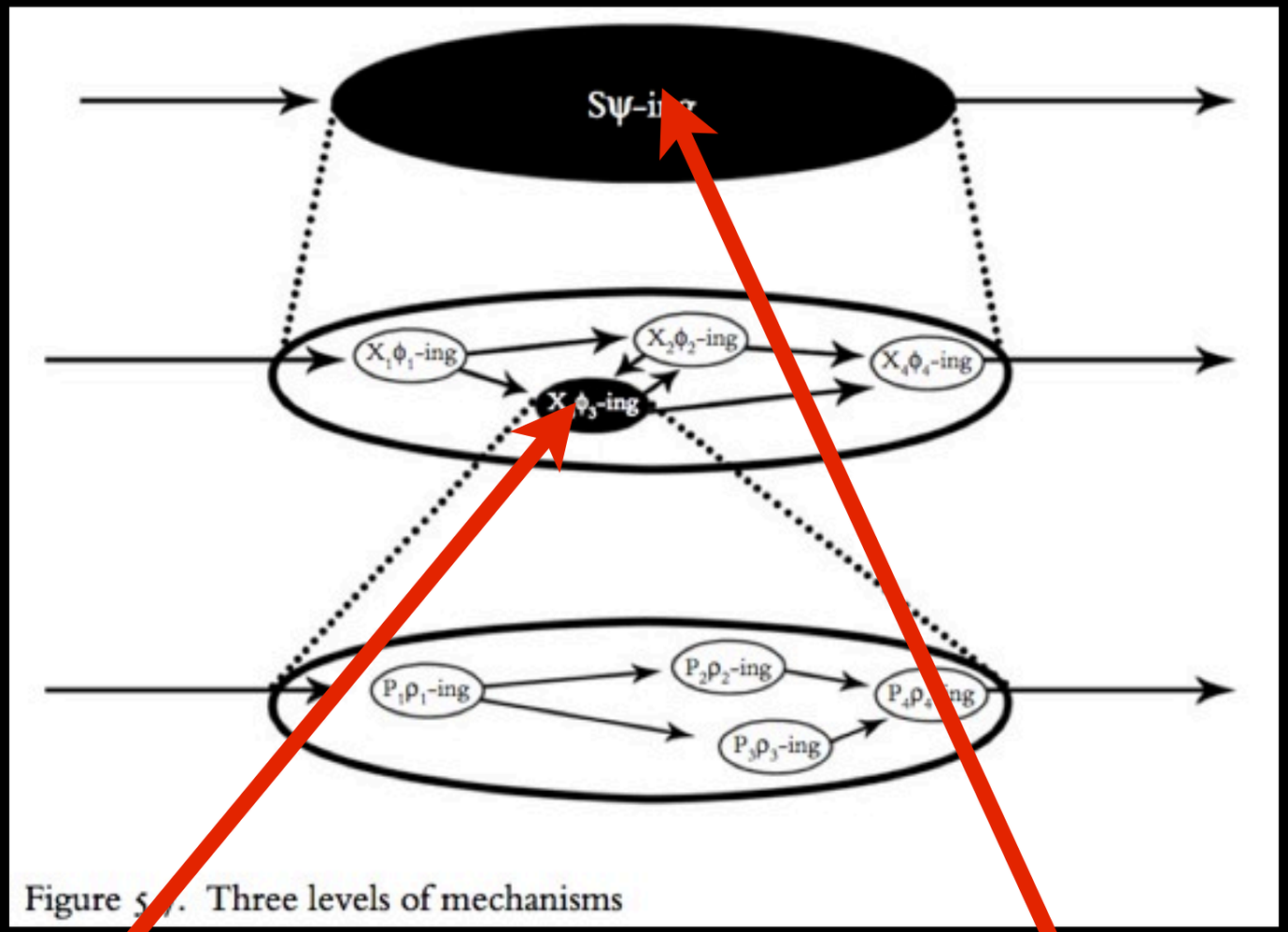


Figure 5.7. Three levels of mechanisms

From Craver (2007)

Entities may have different activities:

S = {ψ, ρ, λ, ... }

Entities within a level interact causally.

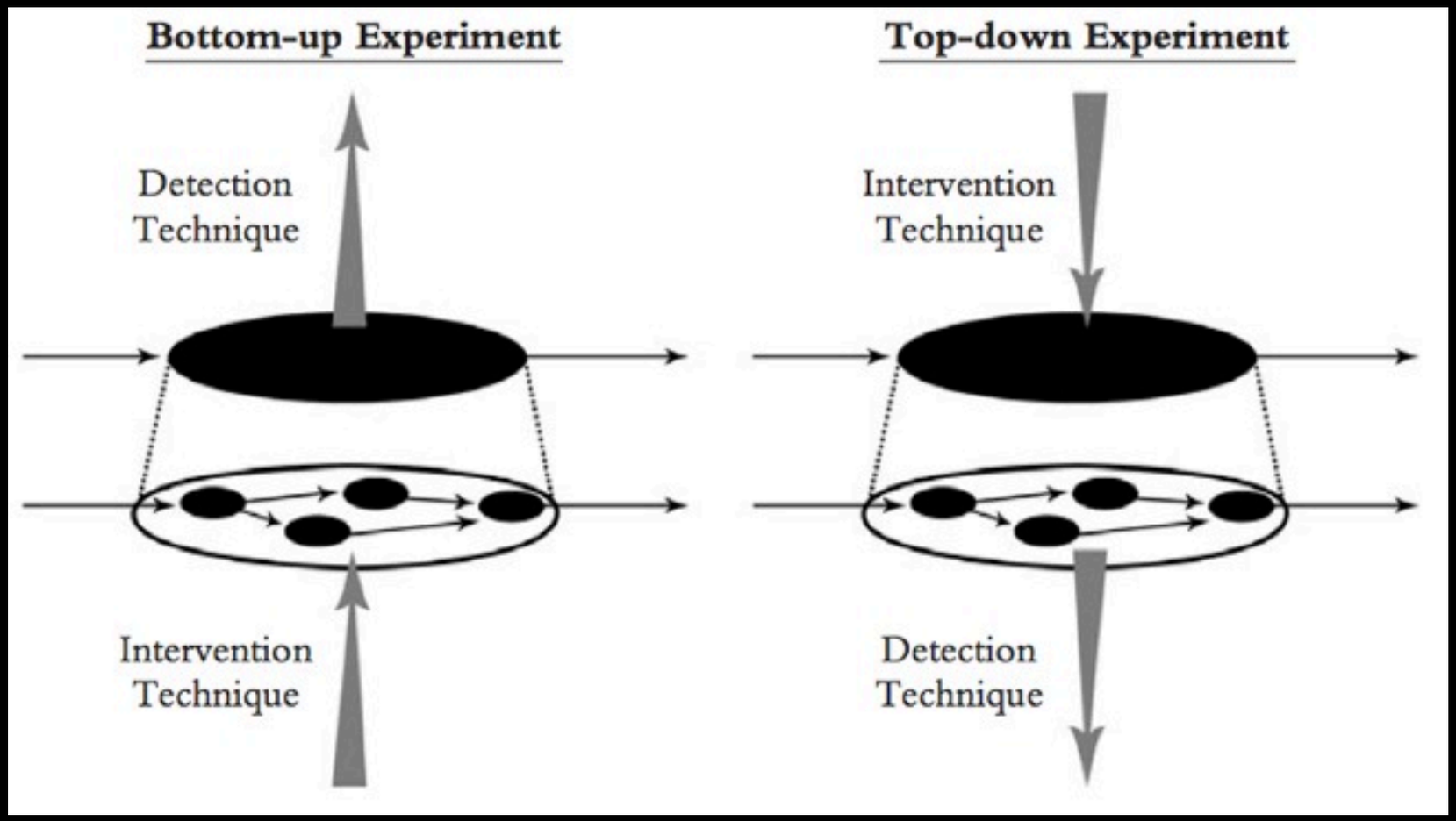
Xϕ is at a **lower mechanistic level** than Sψ
if and only if
Xϕ is a **component** in the mechanism for Sψ.

(Craver, 2007)

Example:
S : subject
ψ : recognizing face
X : cell in fusiform gyrus
ϕ : firing

Mechanistic Explanation

Levels and Mutual Manipulability



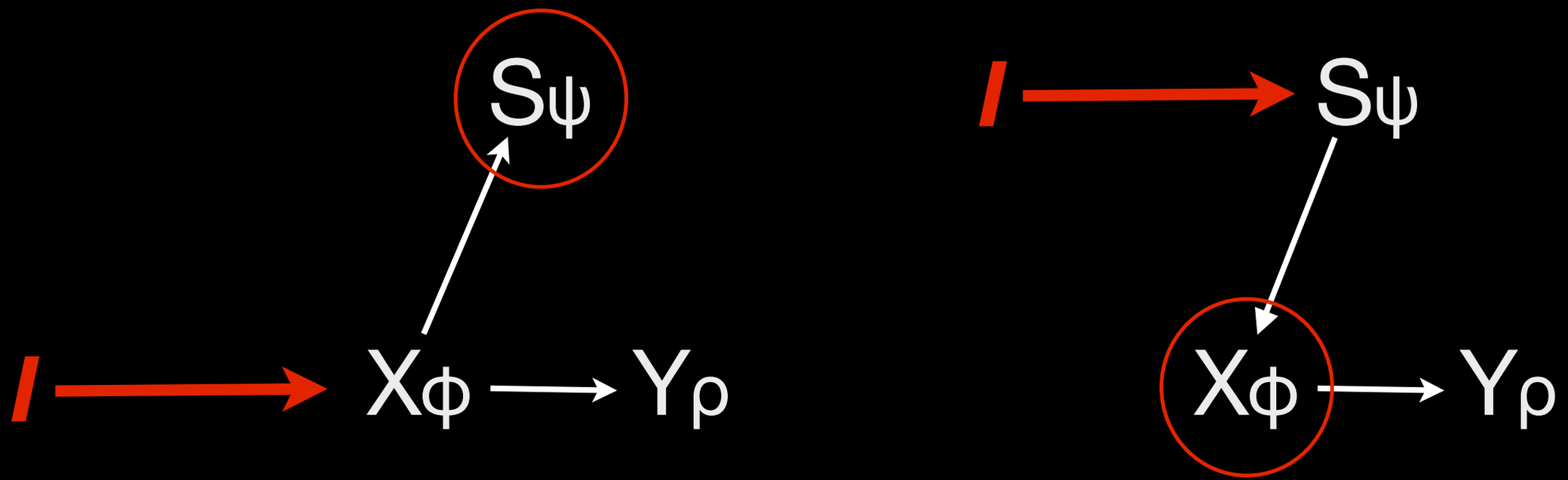
Mutual Manipulability determines Constitutive Relevance:

Bottom-up experiment: patients with damage in fusiform gyrus exhibit prosopagnosia (Damasio, 1982)

Top-down experiment: Subjects identifying facial stimuli. Find activation in a network that includes fusiform gyrus (Ishai et al. 2005)

Mechanistic Explanation

Levels and Mutual Manipulability in a graph



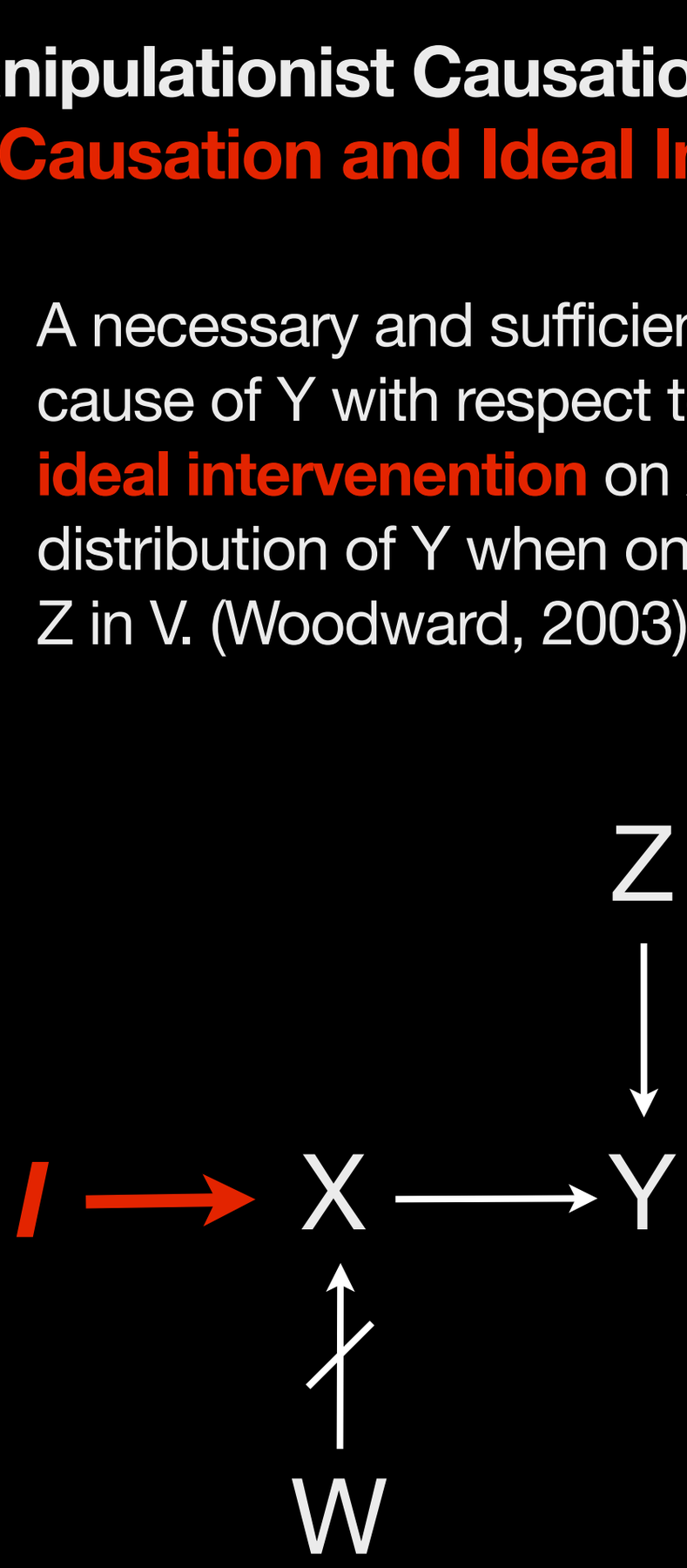
Bottom-up: If Xϕ is at a lower mechanistic level than Sψ, then there is a bottom-up experimental intervention in Xϕ that produces a detectable change in Sψ while keeping everything else constant.

Top-down: If Xϕ is at a lower mechanistic level than Sψ, then there is a top-down experimental intervention in Sψ that produces a detectable change in Xϕ while keeping everything else constant.

Manipulationist Causation

Causation and Ideal Interventions

A necessary and sufficient condition for X to be a (type-level) direct cause of Y with respect to a variable set V is that there be a possible **ideal intervenention** on X that will change Y or the probability distribution of Y when one holds fixed at some value all other variables Z in V. (Woodward, 2003)



_I_ is an ideal intervention on X w.r.t. Y iff

1. _I_ causes X
2. _I_ blocks other influences on X
3. _I_ does not directly cause Y
4. _I_ does not depend on Z

Manipulationist Causation

Manipulationist Argument for Inter-Level Causation

Interventions in the mutual manipulability account satisfy all the conditions to be interventions in the manipulationist account (Leuridan, 2012)

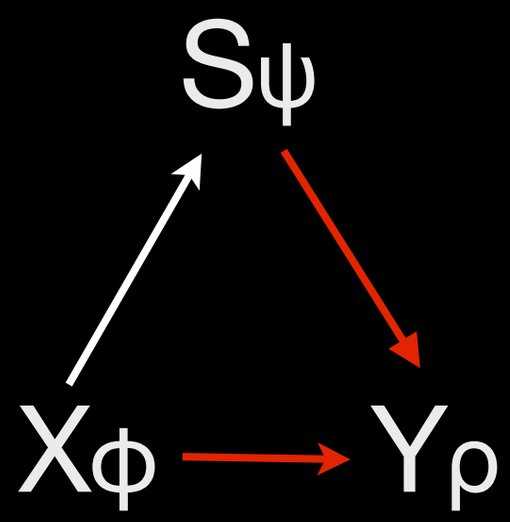
(Bottom-up) If $X\phi$ is at a lower mechanistic level than $S\psi$, then there is a bottom-up experimental **intervention** in $X\phi$ that produces a detectable change in $S\psi$ while keeping everything else constant.

(Causation) A necessary and sufficient condition for X to be a (type-level) direct cause of Y with respect to a variable set V is that there be a possible **intervention** on X that will change Y or the probability distribution of Y when one holds fixed at some value all other variables Z in V.

(Bottom-up Causation) If $X\phi$ is at a lower mechanistic level than $S\psi$, then $X\phi$ is a direct cause of $S\psi$.

Is there Inter-Level Causation?

Reasons not to want it: Redundancy Problem

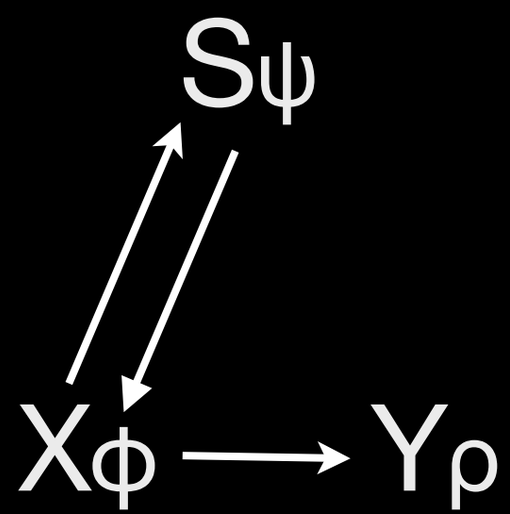


Suppose Yρ has a sufficient same-level set of causes. If there is inter-level causation, then any top-down cause of Yρ is redundant.

(Similar to the interventionist causal exclusion argument by Baumgartner, 2009)

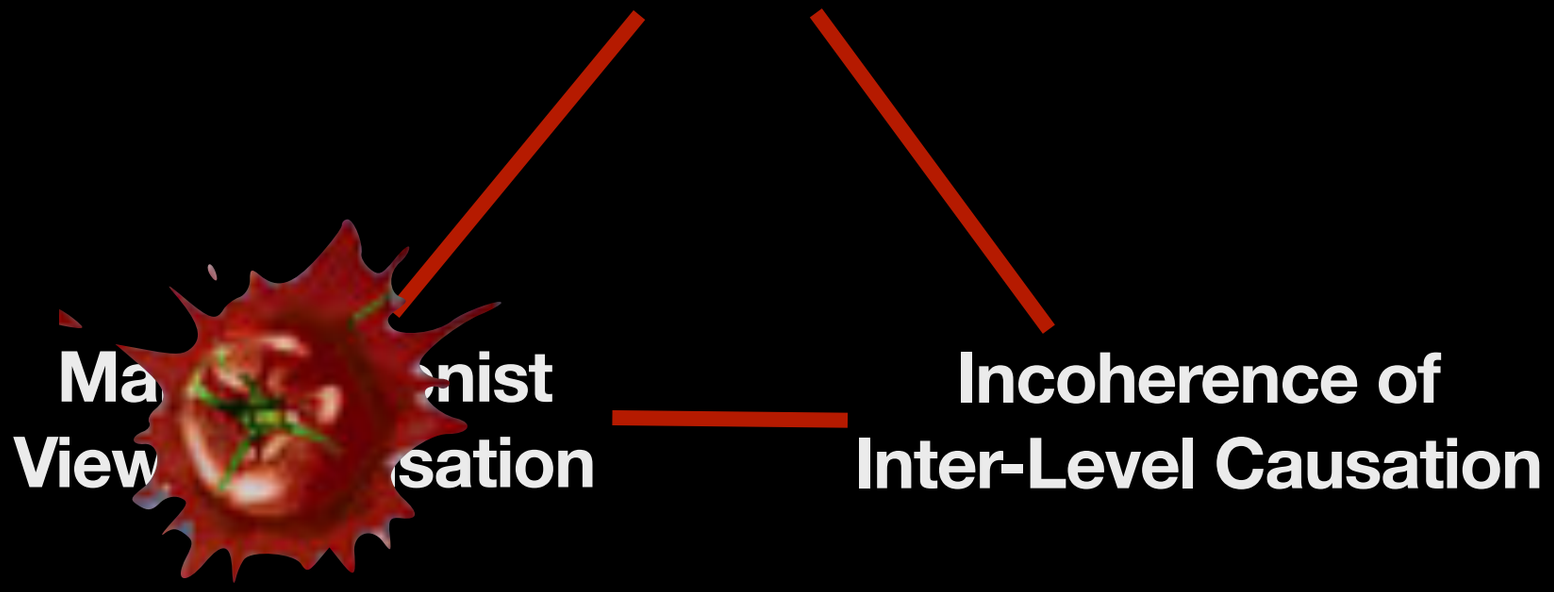
Is there Inter-Level Causation?

Reasons not to want it: Cyclicity Problem



if Xϕ is a component in the mechanism for Sψ, and there is inter-level causation, then there is a causal cycle: Xϕ is a contributing cause of Sψ, and Sψ is a contributing cause of Xϕ.

Solutions?



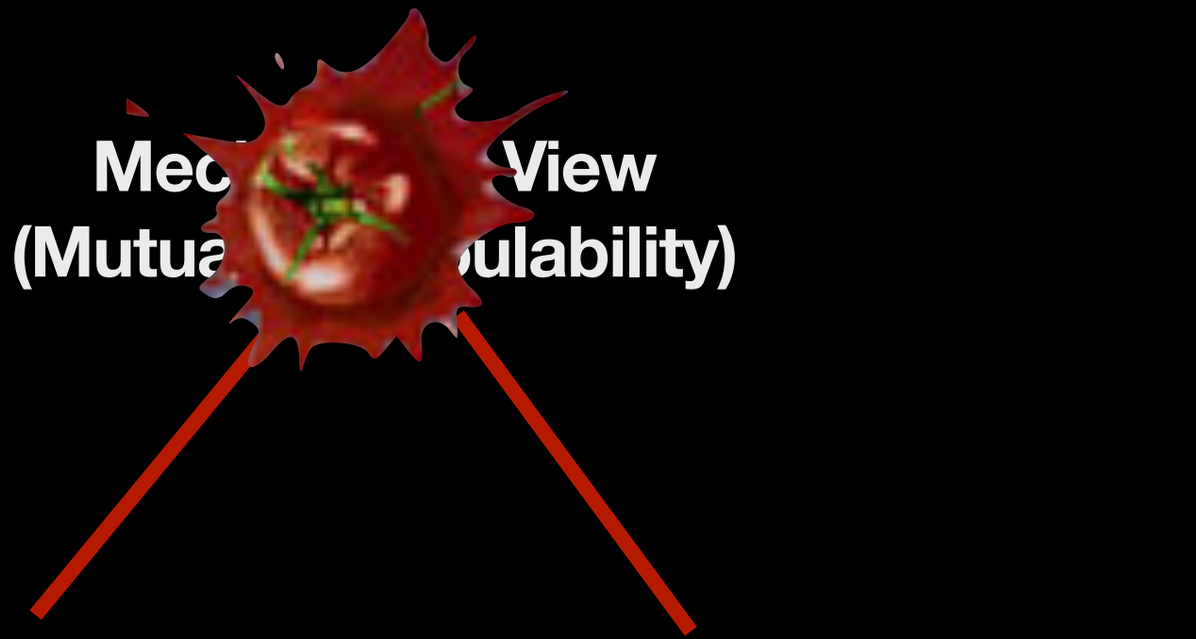
(a) Weaken/reject the Manipulationist View: Argue that an ideal intervention is **(not necessarily)** evidence of a causal relation.

If there is a causal link between X and Y, ***then*** there is (in principle) an ideal intervention on X that produces a change in Y. But not the converse.

Reductionists might find this solution appealing.

Cost: This breaks the connection between the notion of causation and experimental practices.

Solutions?



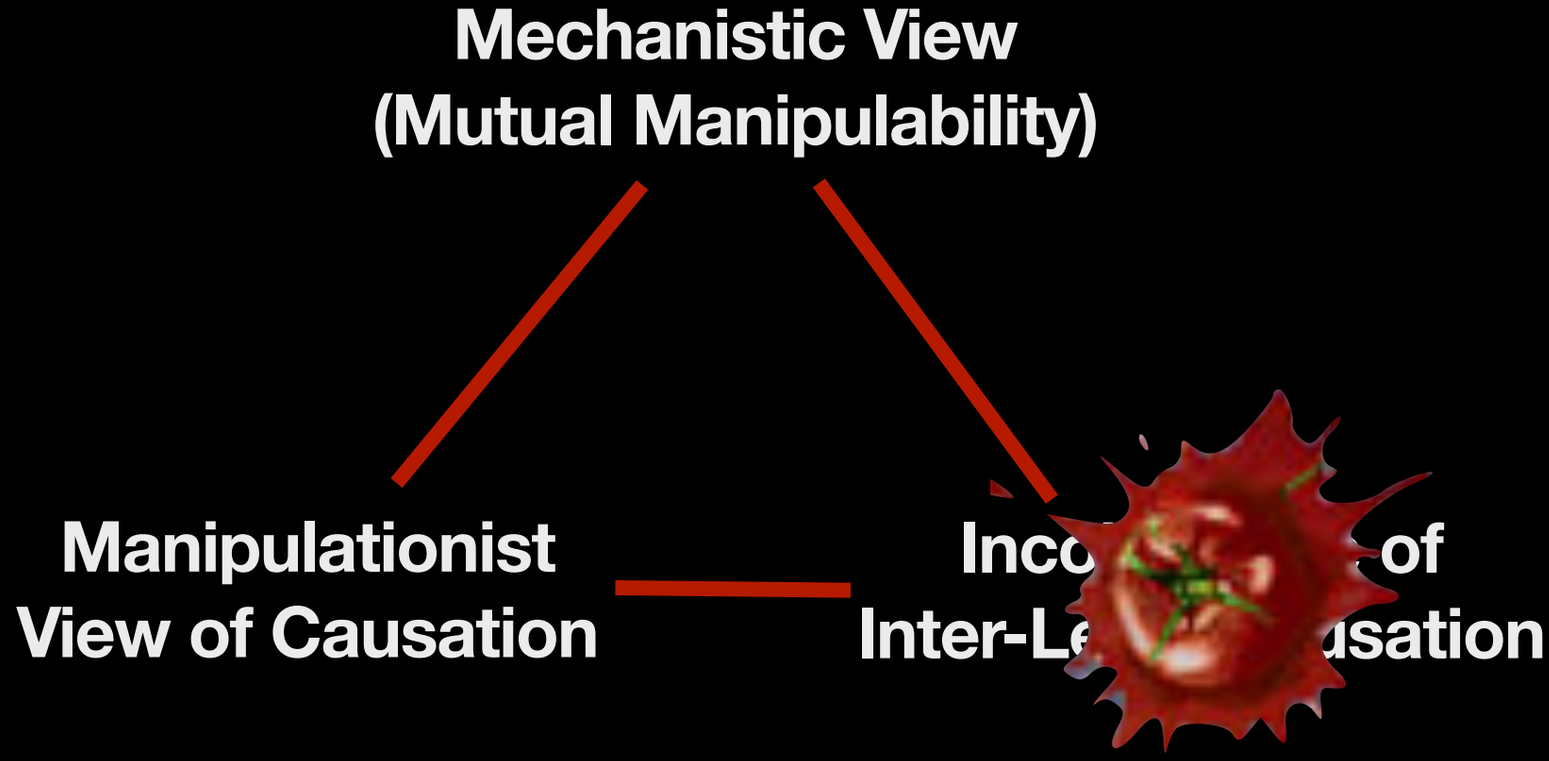
(b) Weaken/reject the Mutual Manipulability account of constitutive relevance

Alternatives?

An example that doesn't work:

Bandwidth criterion: the interactions between a component and the rest of the system are greater than the interactions between the component and other systems (Simon, Haugeland)

Solutions?



(c) Metaphysical Solutions

1. Embrace Inter-Level Causation (Emergence theorists might find this appealing)

2. Argue that in addition to causation and constitution there is *a third type* of relation.

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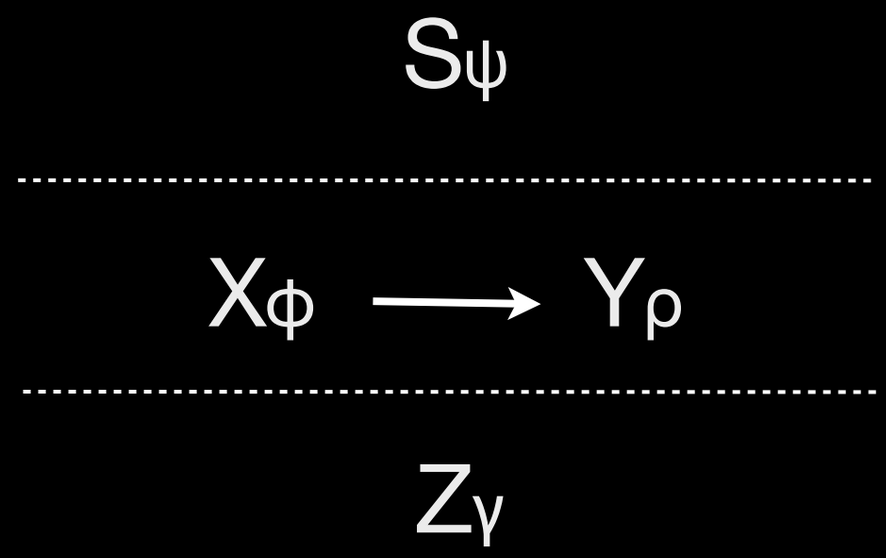
Dissolving the Problem

Mechanisms in Causal Graphs



Causal Graph: G = (**Entities_Activities**, **Causal Relations**)

Entities: S, X, Y, Z
Activities: S = {ψ, ϕ, ρ, ... , }
Fusiform gyrus = {face recognition, word recognition, categorization}
Basal ganglia = {language comprehension, emotions, OCD, memory}

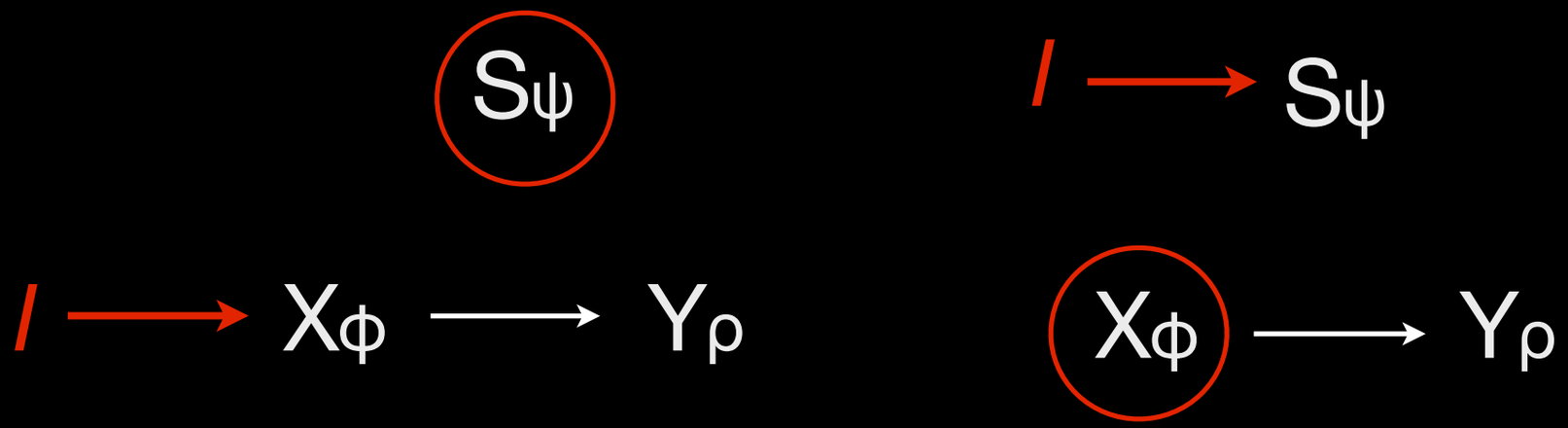
Not completely hierarchical.

No commitments to specific views of spatial organization/localization.

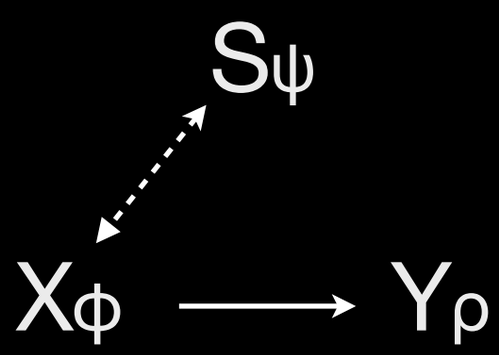
Dissolving the Problem

Modeling Constitutive Relevance

Mutual Manipulability



Less committal conclusion: correlation (Xϕ <---> Sψ)



If Xϕ is a component in Sψ, then there is an edge Xϕ <---> Sψ in G
(i.e,. they are correlated)

Dissolving the Problem

Where is Causation?

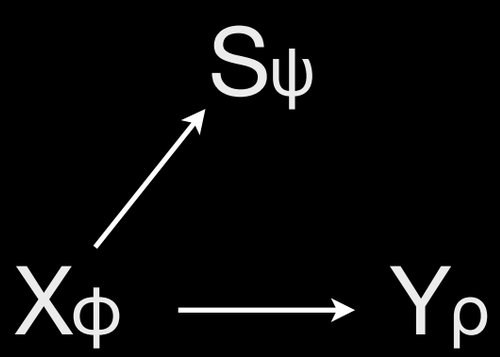
We have to explain the correlation X_ϕ <---> S_ψ

Reichenbach's common-cause assumption: If there is a correlation between X_ϕ and S_ψ, then either

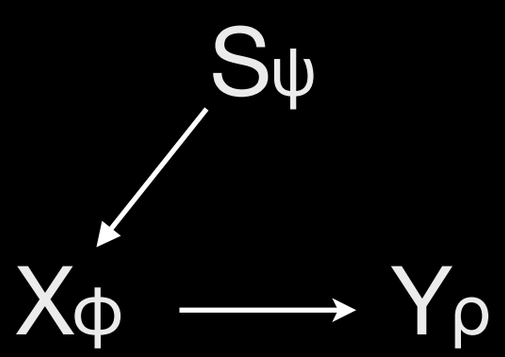
(1) X_ϕ is a cause of S_ψ,

or (2) S_ψ is a cause of X_ϕ,

or (3) there is a common cause U, that causes both X_ϕ and S_ψ.



(1)



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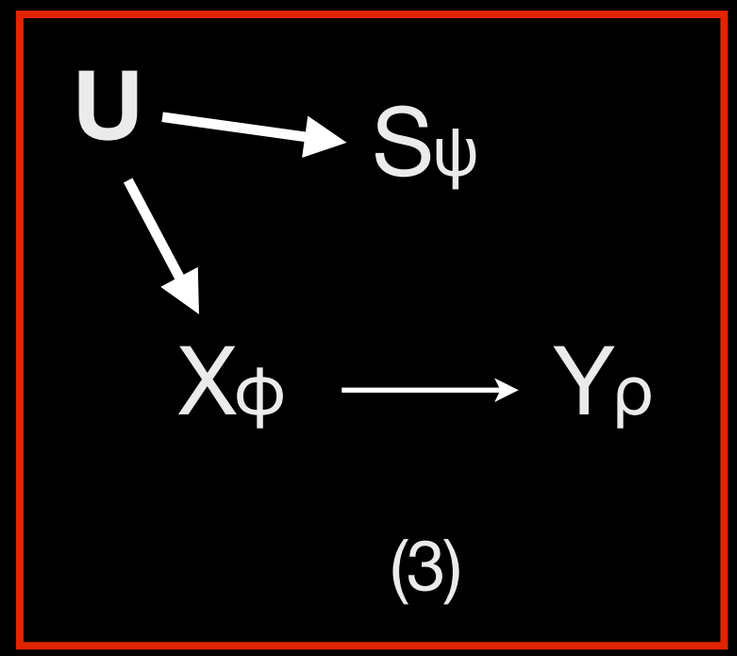
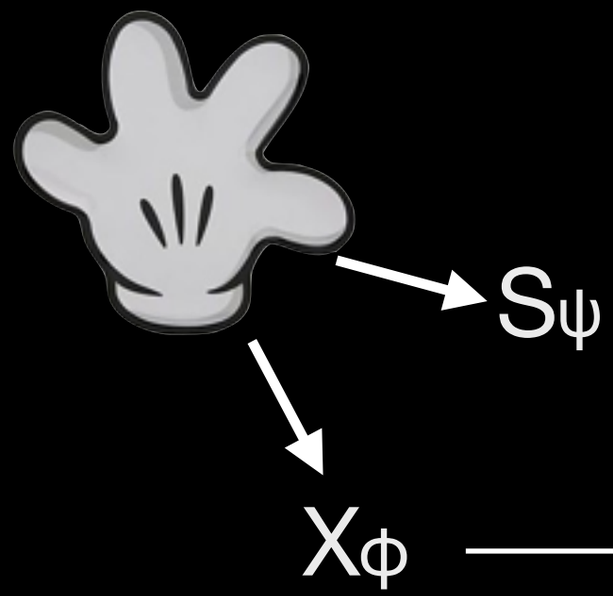


(3)

Dissolving the Problem

Constitution and Fat-handedness

Fat-handed Intervention: An intervention that cannot manipulate one variable without necessarily changing other.



Examples:
opioids: treatment for pain AND antidepressants
x-rays: imaging technique AND radiation effects
anti-psychotics: eliminate psychotic symptoms AND impair movement

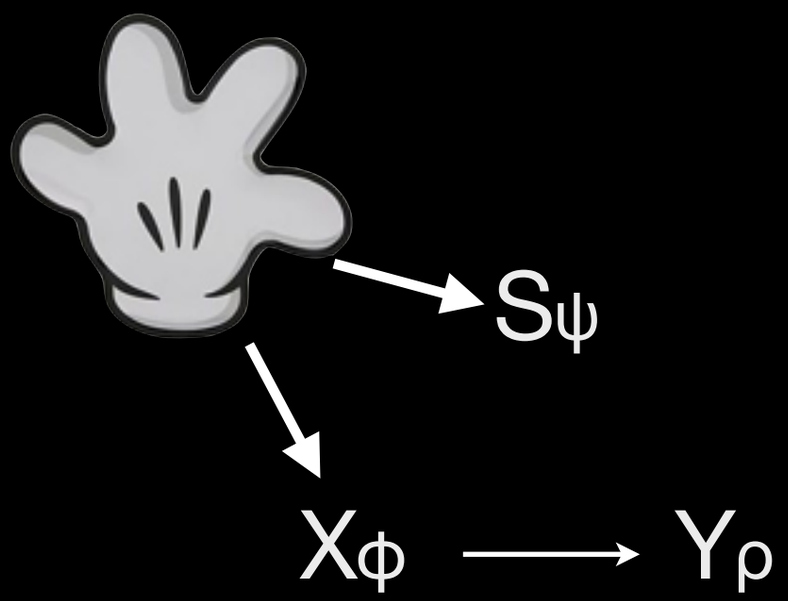
Claim: Interventions that provide evidence for constitutive relevance in mechanisms are fat-handed interventions.

The observed correlations are directly caused by the intervention.

Dissolving the Problem

Fat-handed Interventions on Mechanisms

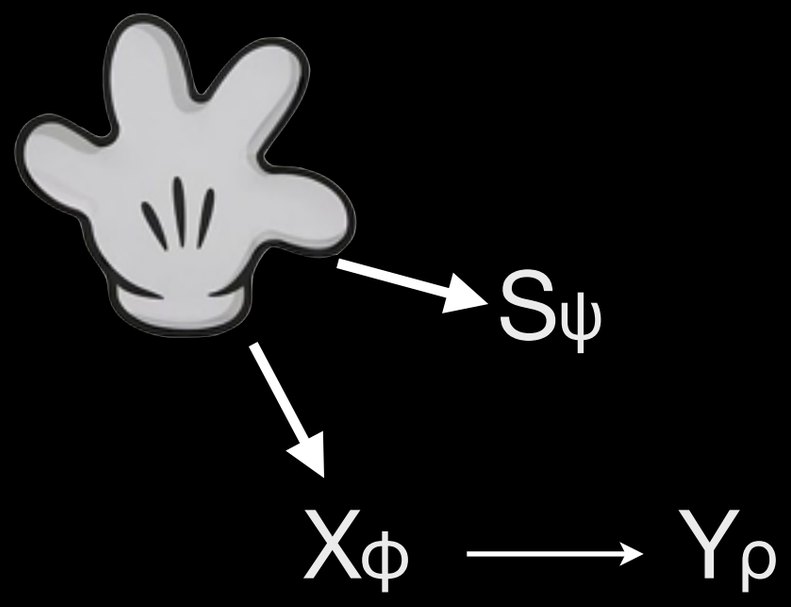
Example 1. (Sperry, 1980) You push a tire (intervention), the tire moves ($S\psi$) and its rubber molecules also move ($X\phi$). You observe a correlation between the two variables. However, there is no way of making the intervention without producing both effects. The intervention itself causes both.



Dissolving the Problem

Fat-handed Interventions on Mechanisms

Example 2. You take an aspirin (intervention) and it relieves your pain (S_ψ). Aspirin suppresses the production of prostaglandins (X_ϕ), which are associated with transmission of pain information to the brain. It is not possible for the aspirin to relieve your pain without suppressing the production of prostaglandins, or the other way around (controlling for other influences).



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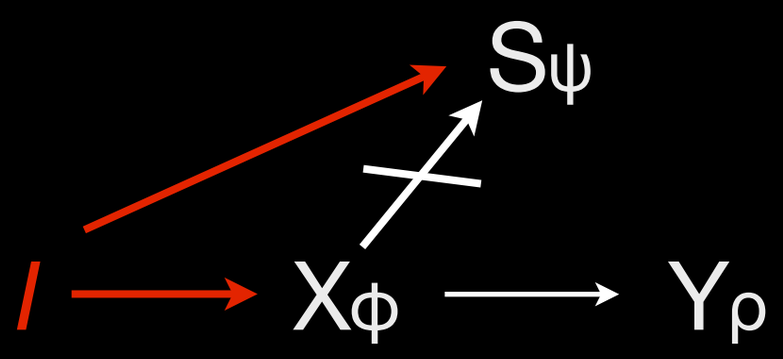
Argument Against Inter-Level Causation

Suppose X_ϕ is a component in S_ψ, and *I* is an intervention that causes X_ϕ

then, *I* is a fat-handed intervention with respect to X_ϕ and S_ψ,

then, *I* is **not** an ideal intervention on X_ϕ with respect to S_ψ,

then, X_ϕ does not directly cause S_ψ. (no bottom-up causation)



***I* is an ideal intervention on** Xϕ **w.r.t.** Sψ **iff**
1. *I* causes Xϕ
2. *I* blocks other influences on Xϕ
3. ***I* does not directly cause Sψ**
4. *I* does not depend on other variables Z

(Causation) X directly causes Y with respect to a variable set V iff **there is an ideal intervention on X that will change Y** or the probability distribution of Y when one holds fixed at some value all other variables Z in V.

Argument Against Inter-Level Causation

Implications

Cyclicity and Redundancy turn out to be apparent problems:

Redundancy. Physicalist assumption: For every Yρ at the lowest level of reality there is a sufficient same-level set of causes. If **there is inter-level causation**, then any top-down cause of Yρ is redundant.

Cyclicity. if Xϕ is a component in the mechanism for Sψ, **and there is inter-level causation**, then there is a causal cycle: Xϕ is a contributing cause of Sψ, and Sψ is a contributing cause of Xϕ.

Summing Up

There is *only an apparent* tension between the Mechanistic View of Explanation and the Manipulationist View of Causation in the notion of intervention.

Fat-handedness provides a natural way of thinking about interventions in mechanisms.

If interventions that provide evidence for constitutive relevance are fat-handed, then there are no inter-level causal relations between components.

This solution reconciles Mechanistic Explanation, Manipulationist Causation, and the Incoherence of Inter-Level Causation.