Hartmut Esser (University of Mannheim)
Julian Seuring (Lifbi Bamberg)

What is Your Replicandum?

On the importance of an explicit theoretical foundation of the definition of estimands, especially in replications, using the example of the debate on Ability-Tracking

Seminar
„Analytical Sociology: Theory and Empirical Applications“
Venice14 th. November 2022

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Estimands and Replicands
The Dispute
Theory
Re-Corrections
Conclusions

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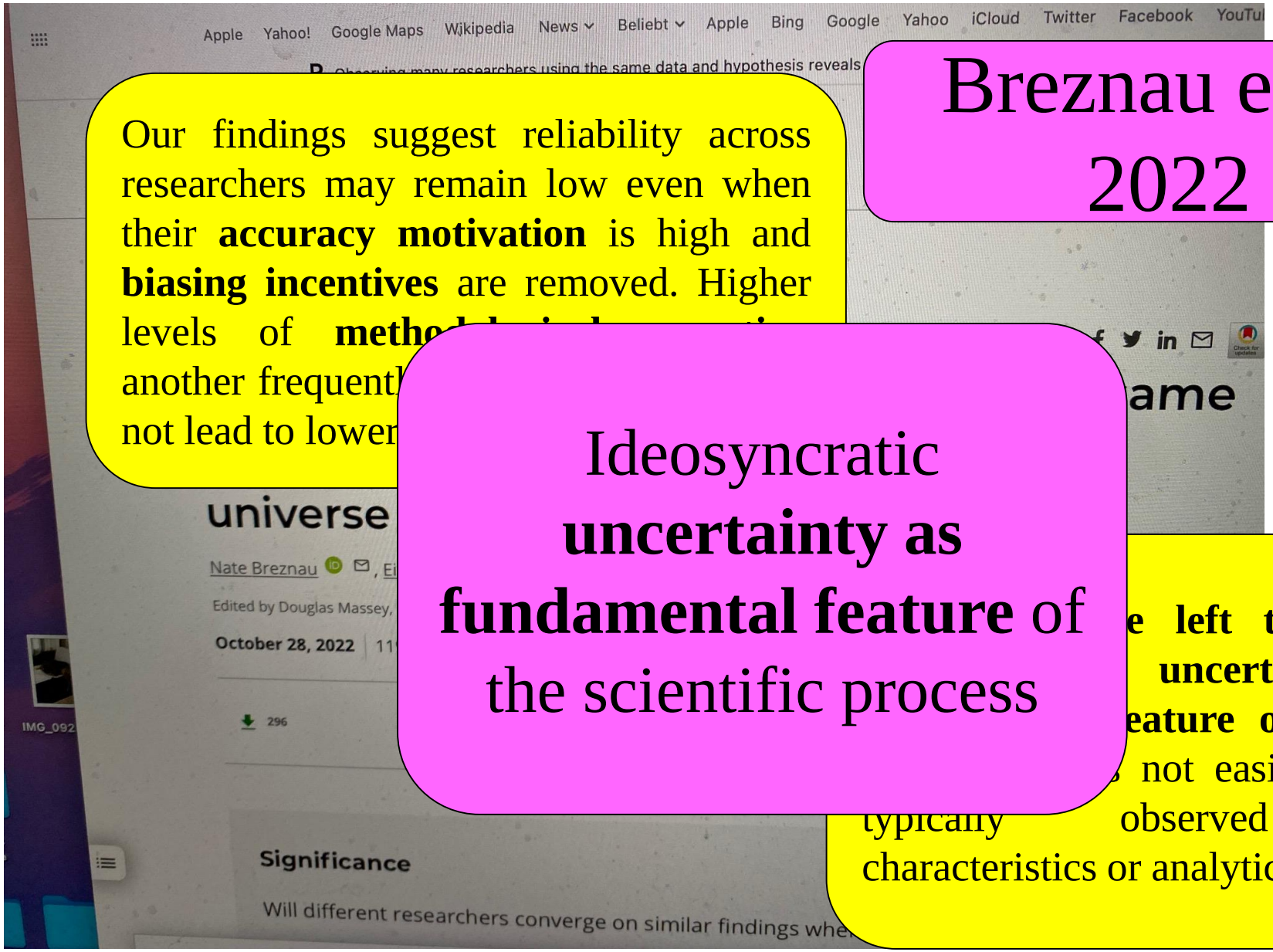


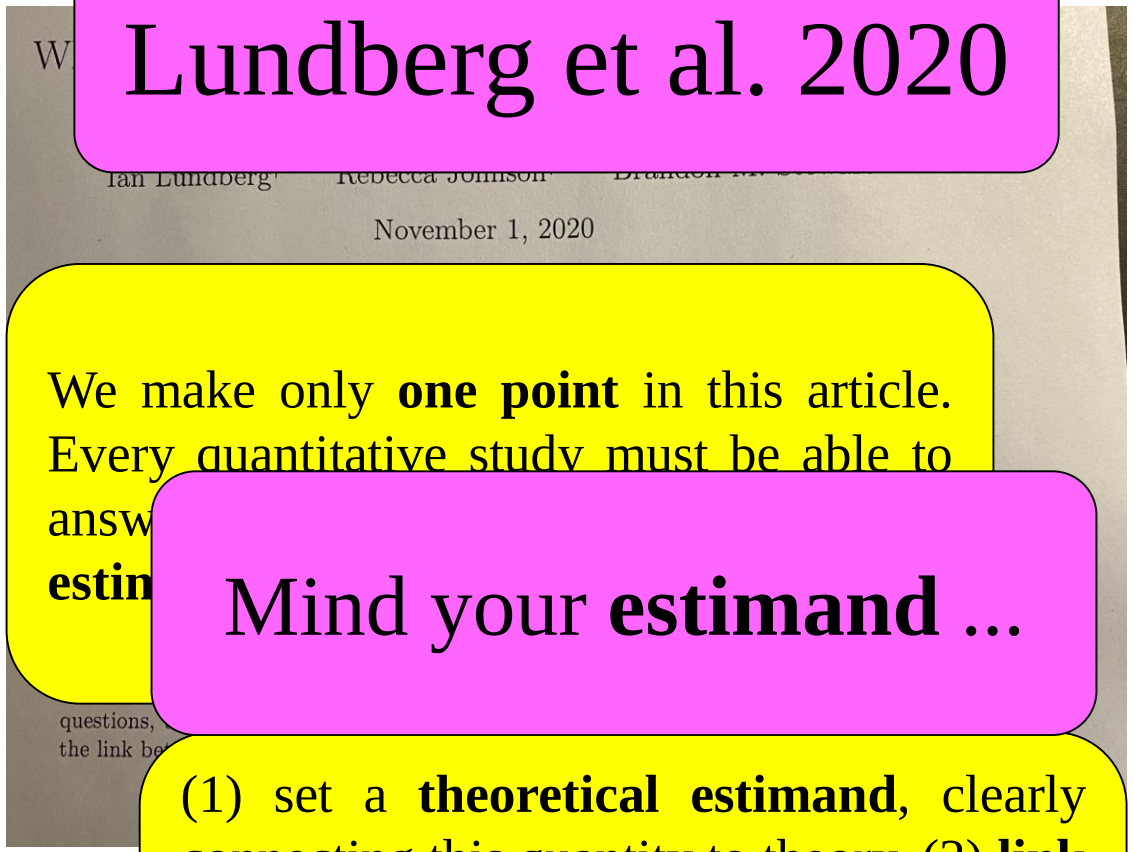
Our findings suggest reliability across researchers may remain low even when their **accuracy motivation** is high and **biasing incentives** are removed. Higher levels of **metho** another frequent not lead to lower

Breznau et al. 2022

Ideosyncratic **uncertainty as fundamental feature** of the scientific process

e left to believe that uncertainty is a eature of the scientific not easily explained by typically observed researcher characteristics or analytical decisions.

Lundberg et al. 2020


November 1, 2020

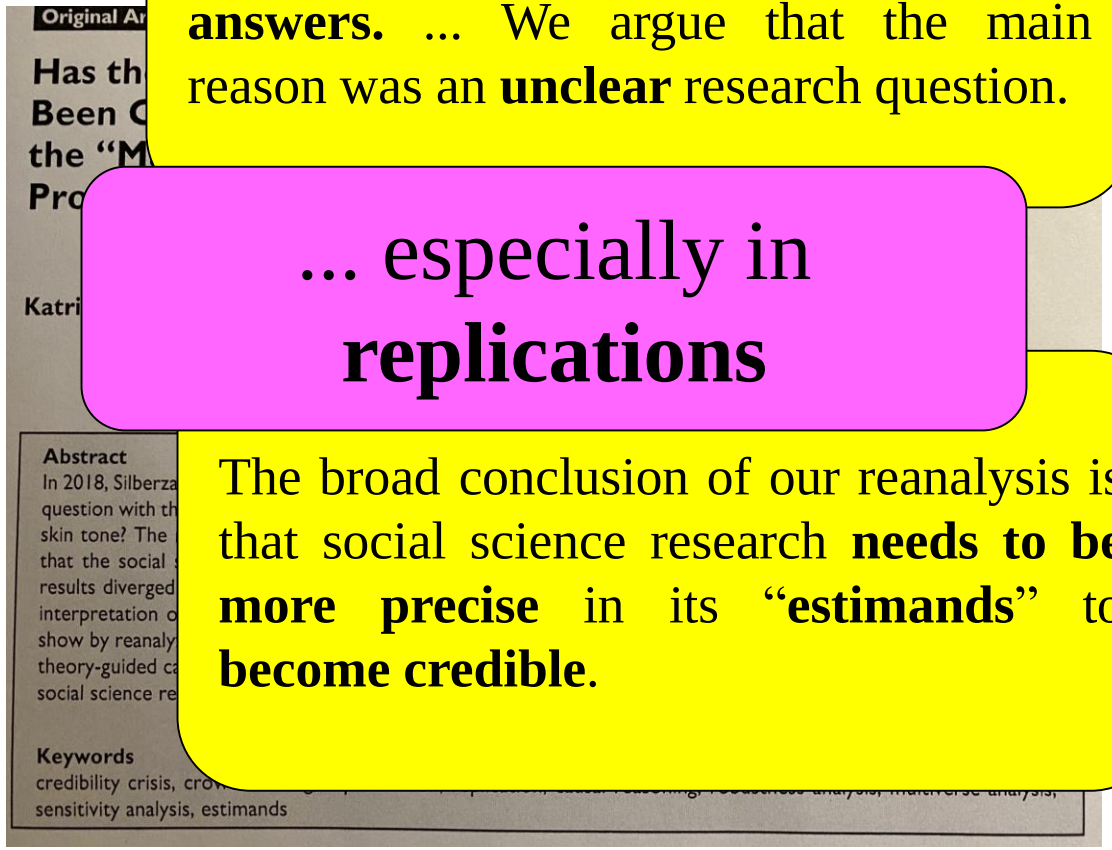
We make only **one point** in this article. Every quantitative study must be able to answ
estim

Mind your **estimand** ...

(1) set a **theoretical estimand**, clearly connecting this quantity to theory, (2) **link** to an empirical estimand, which is **informative about the theoretical estimand** under some identification assumptions,

Auspurg&Brüderl 2022

... that the **social sciences are not rigorous enough to provide definitive answers.** ... We argue that the main reason was an **unclear** research question.


Has th
Been C
the "M
Pro
Katri
Abstract
In 2018, Silberza
question with th
skin tone? The
that the social
results diverged
interpretation o
show by reanaly
theory-guided ca
social science re
Keywords
credibility crisis, cro
sensitivity analysis, estimands

... especially in **replications**

The broad conclusion of our reanalysis is that social science research **needs to be more precise** in its "**estimands**" to **become credible**.

A first conclusion

Replications are absolutely **necessary**, but are **no** warranty for „truth-(approximation)“

Problem 1: **Stable repetition** of the same mistakes.

Problem 2: **False refutation** of a correct model.

Main point:

Valid analyses and replications **presuppose** a well-founded and explicit **theory/causal model**, which **defines** the theoretical and empirical estimands, and **any** change against the original study has to be justified by a well-founded and explicit **theoretical** argument.

Main aim:

Demonstrating how important **careful** attention to **theoretical** guidelines can be in making correct or false decisions in the research process, but especially in replications.

Topic: Effects of Ability-Tracking

general: Is „Ability“-Tracking theoretically **equivalent** to „Achievement“-Tracking?
specific: Simultanuous **control** of Abilities and Achievement allowed?

Estimands and Replicands
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Two Positions

Differentiation-Position

Sörensen 1970
Sörensen&Hallinan 1974

Cognitive **homogeneity** of school classes allows better adaptation of **curriculum and instruction** – **achievement** higher **without** increasing social inequality.

Integration-Position

Oakes 1985
Gamoran 2009

Support by **peer-interactions** possible only with **heterogeneity** of school classes (with late or no sorting at all) – **achievement** higher **without** incresing social inequality.

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Cognitive **homogeneity** of school classes allows better adaptation of curriculum and instruction: achievement higher (without increasing social inequality).

Integration-Position

Oakes 1985
Gamoran 2009

Support by peer-interactions possible only with **heterogeneity** of school classes (with late or no sorting at all): achievement higher (with decreasing social inequality).

„ ... where **tracking** systems are present, **achievement** tends to **diverge**, and to **reinforce** initial differences by **social class**.“

Gamoran 2009: 9

really?

... in its **empirical** approach **far away** from the respective **theoretical** foundations!

Empirical Findings

...
Wößmann et al. 2009
Müller&Kogan 2010
van de Werfhorst &Mijs 2010
Müller&Kogan 2010
Becker&Solga 2012
Strello et al. 2019
Terrin&Triventi 2022
...

The actual case

... extension and completion of Sörensen&Hallinan (1970, 1977, 1994)

Contribution from **Esser&Seuring (2020)** showing that, contrary to the standard position, with strict Ability-Tracking the effects of social background do not increase and achievement in secondary school rises, also on the fact that the effects of cognitive homogeneity of school classes increase, in favor of children just at the lower levels.

... extension and completion of Sörensen&Hallinan (1970, 1977, 1994)

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NEPS

German country states

„Stringency“ (T)

Bindingness & Control

Correcting replication!

Rejoinders & Replications

Klemm 2021
Matthewes&Heisig 2022
Lorenz et al. 2022

ONE
central substantial point

10 Points

1. No generalization to the full international variance in systems
2. NEPS: case numbers too small and biased distributions
3. Wrong operationalization of class composition („leave-i-out“)
4. Wrong and misleading mediation-analyses
5. Interaction of cognitive niveau and homogeneity
6. Control of school-types
7. Abilities and achievements as equivalents
8. No control of achievements before
9. Primary System-Effects
10. Two-way- instead of three-way-interactions

Ability and Achievement

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Ability and Achievement

The crucial quote

... it (is) possible to control for outcome differences (in achievements in grade 5) at baseline ... in the regressions for grade 7 achievement. Somewhat surprisingly, ES do not make use of this information in their paper. (**NN 2022: 105**)

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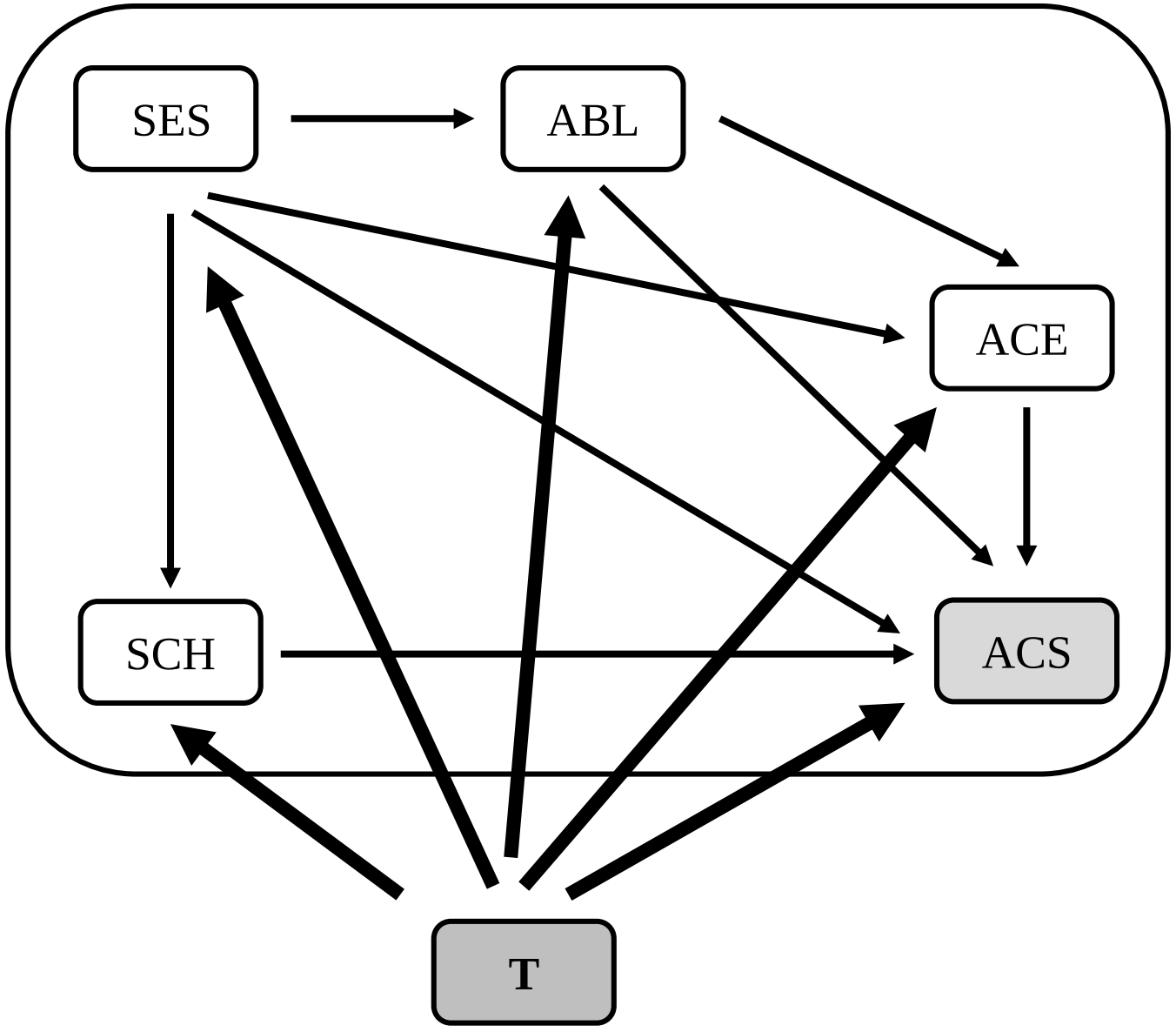
... indeed!

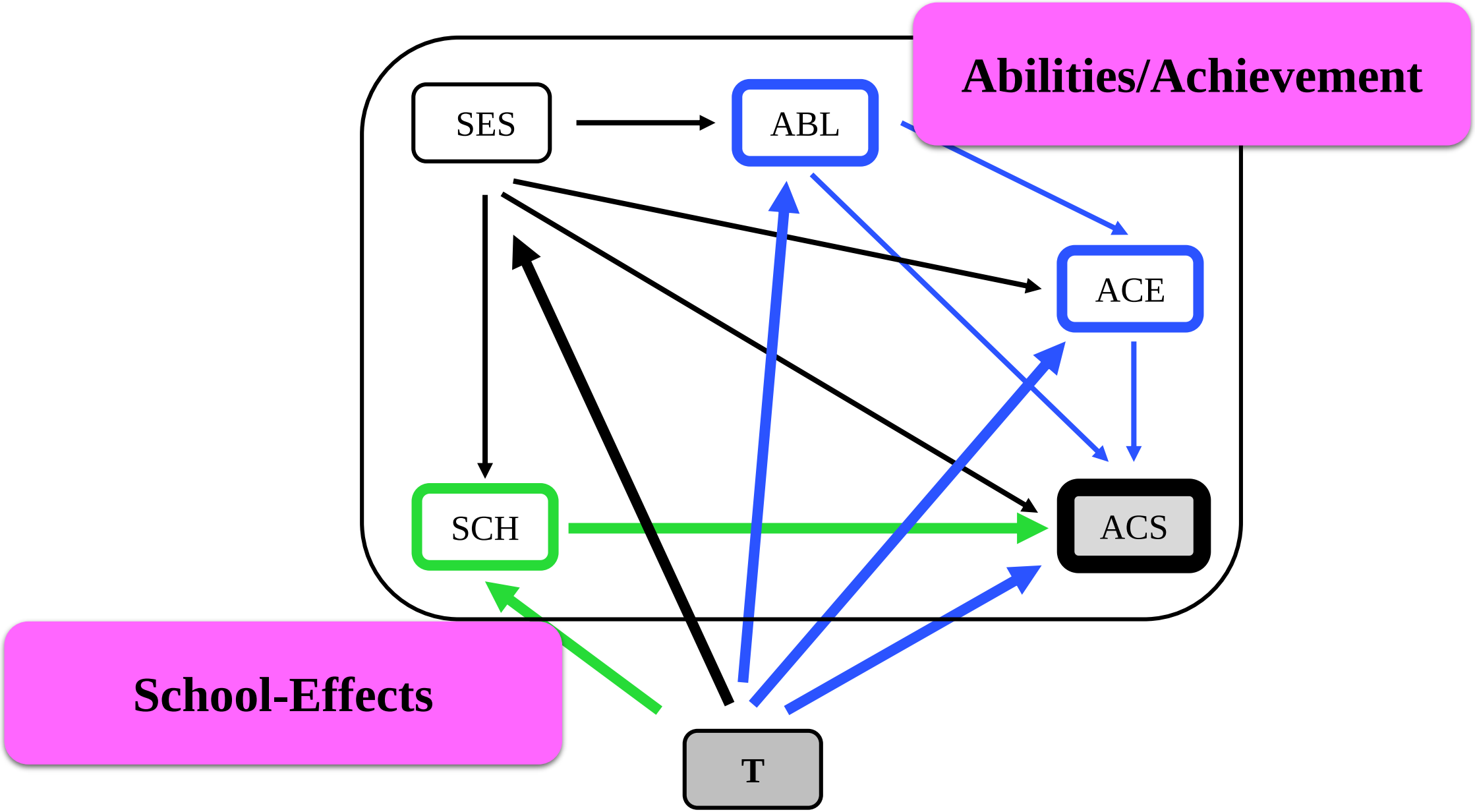
... but why?

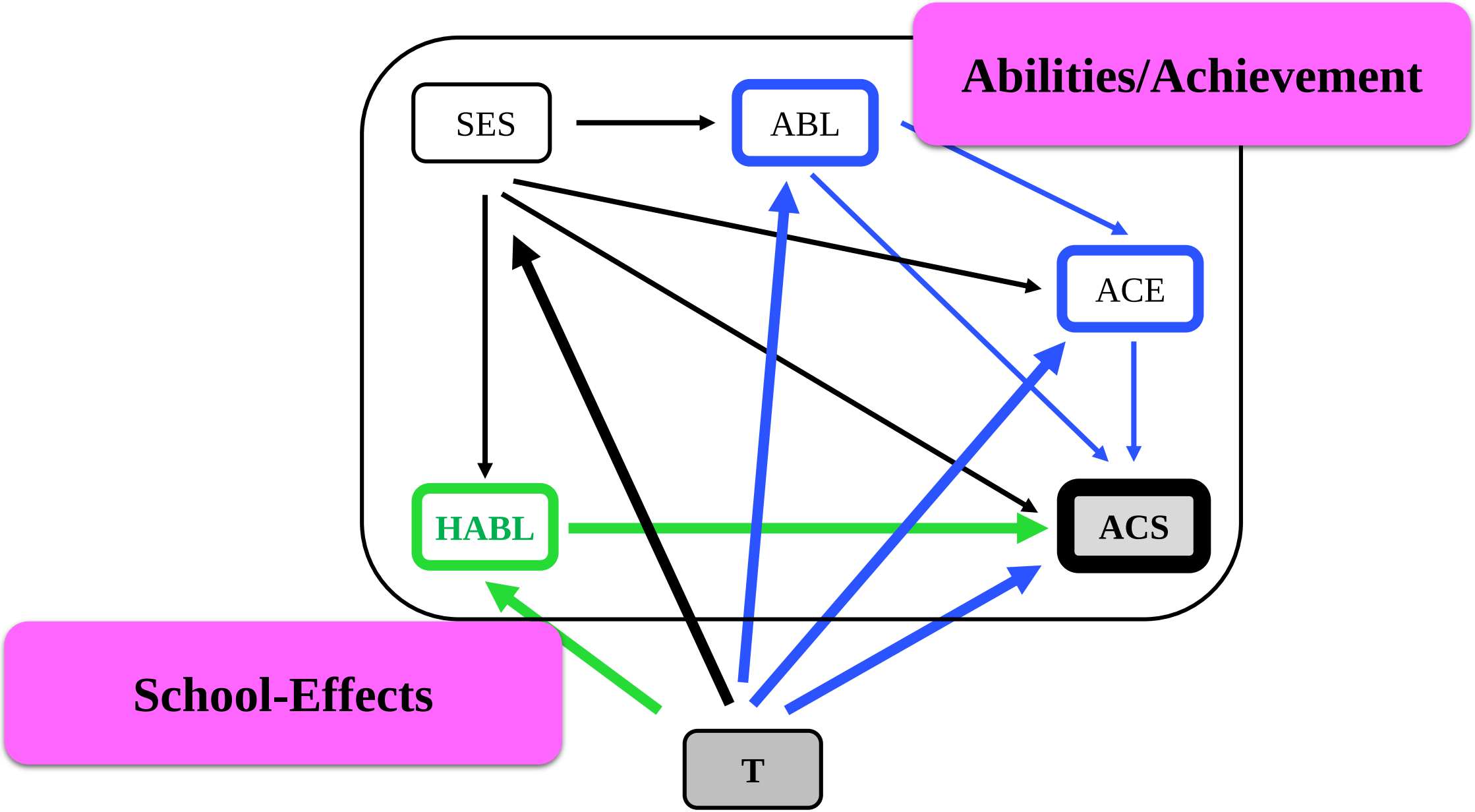
Theoretical Background

MoAbiT
(Causal Model)

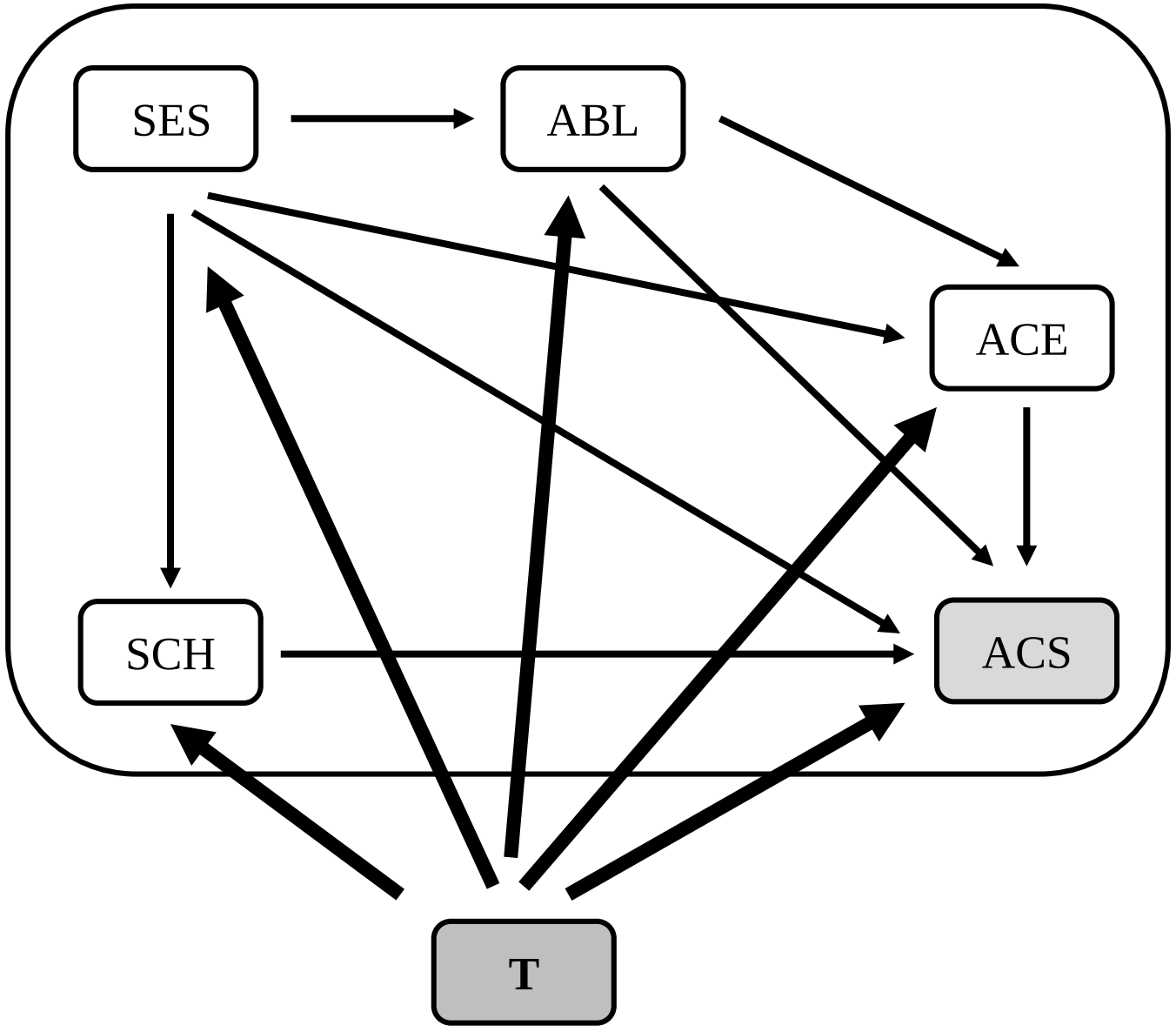
... simplified
(secondary school only)

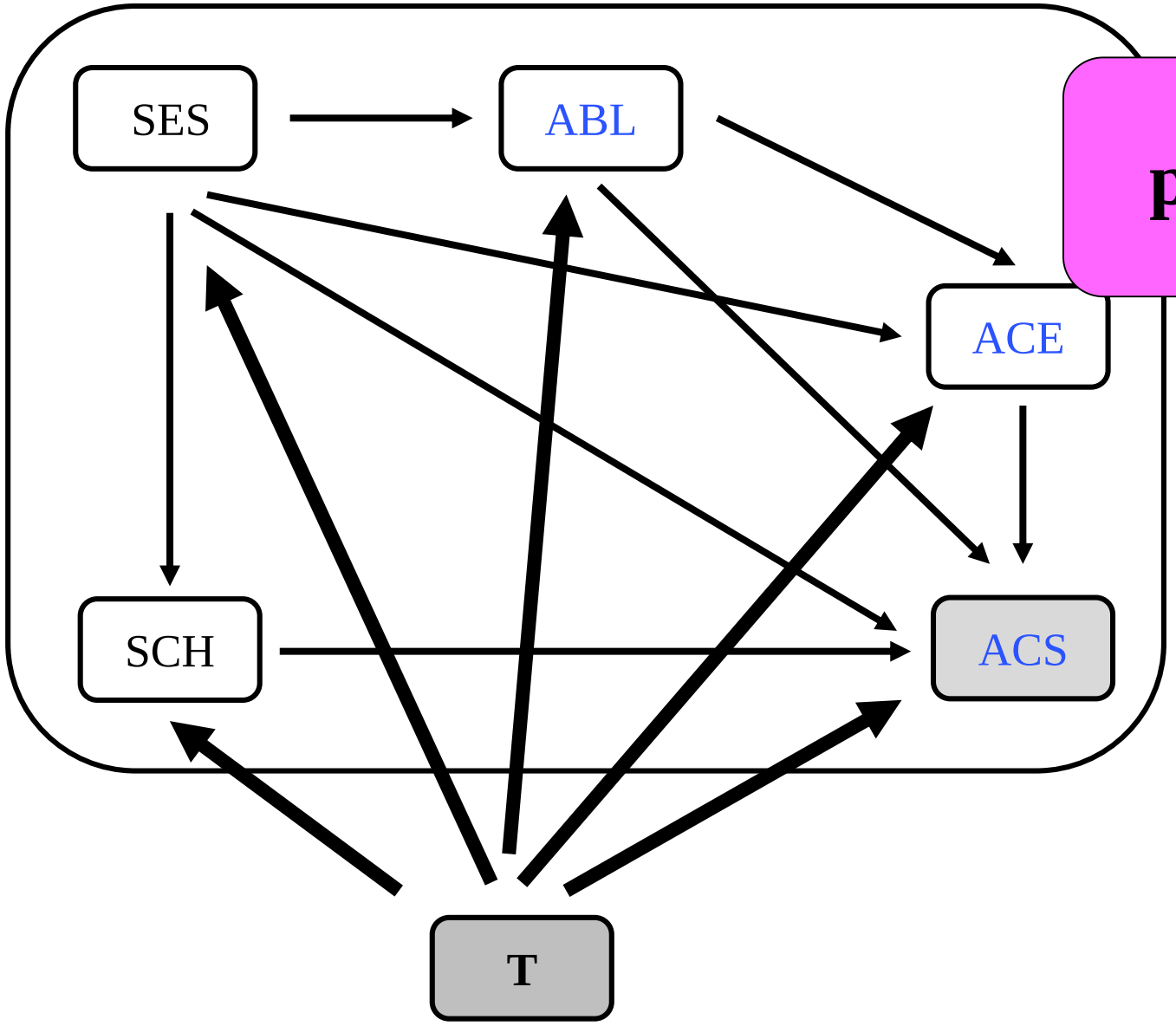

SES
ABL
ACE
SCH
ACS
T


Abilities/Achievement
SES
ABL
ACE
SCH
ACS
School-Effects
T

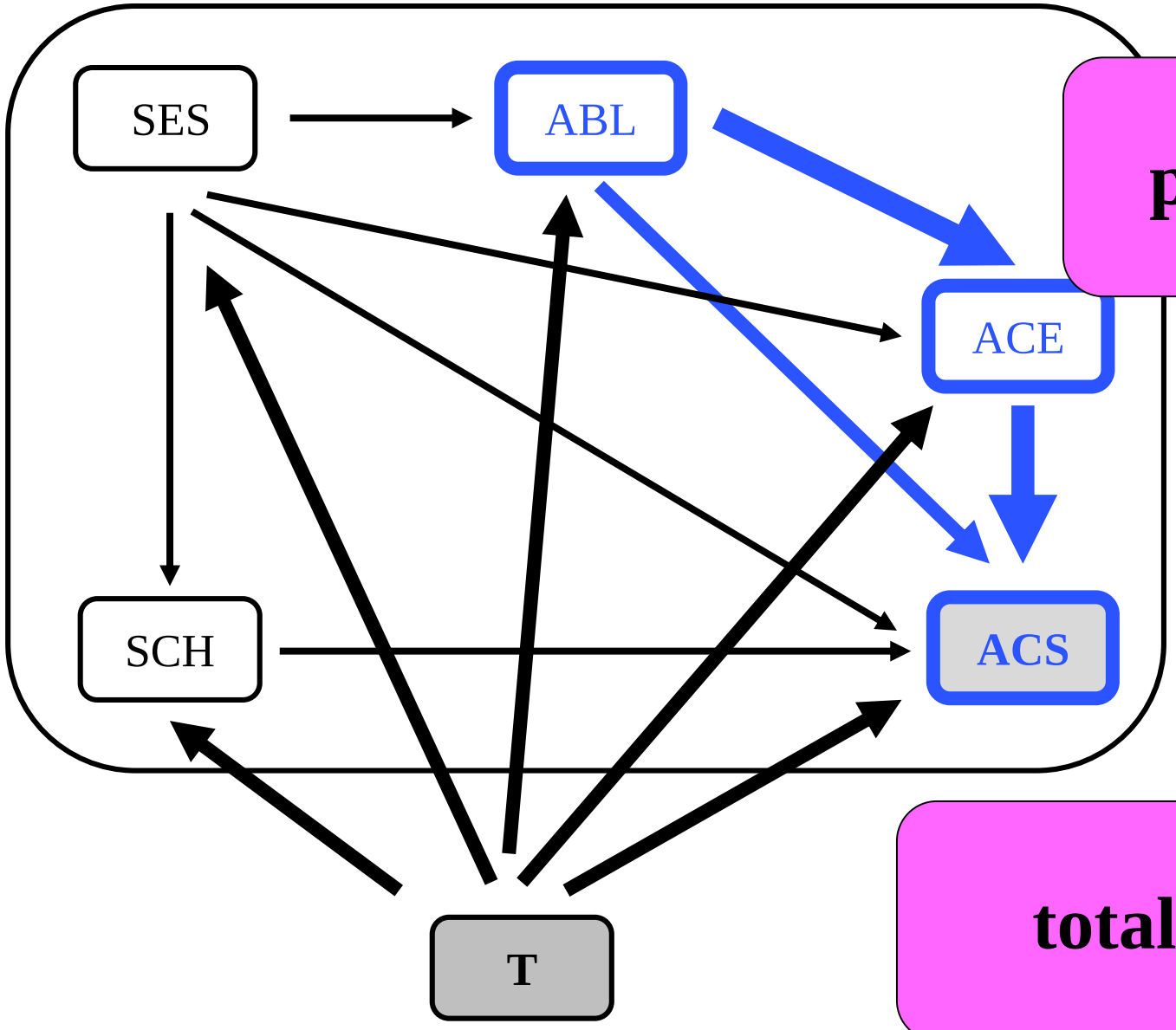

Abilities/Achievement
SES
ABL
ACE
HABL
ACS
T
School-Effects

Control for ACE?


SES
ABL
ACE
SCH
ACS
T

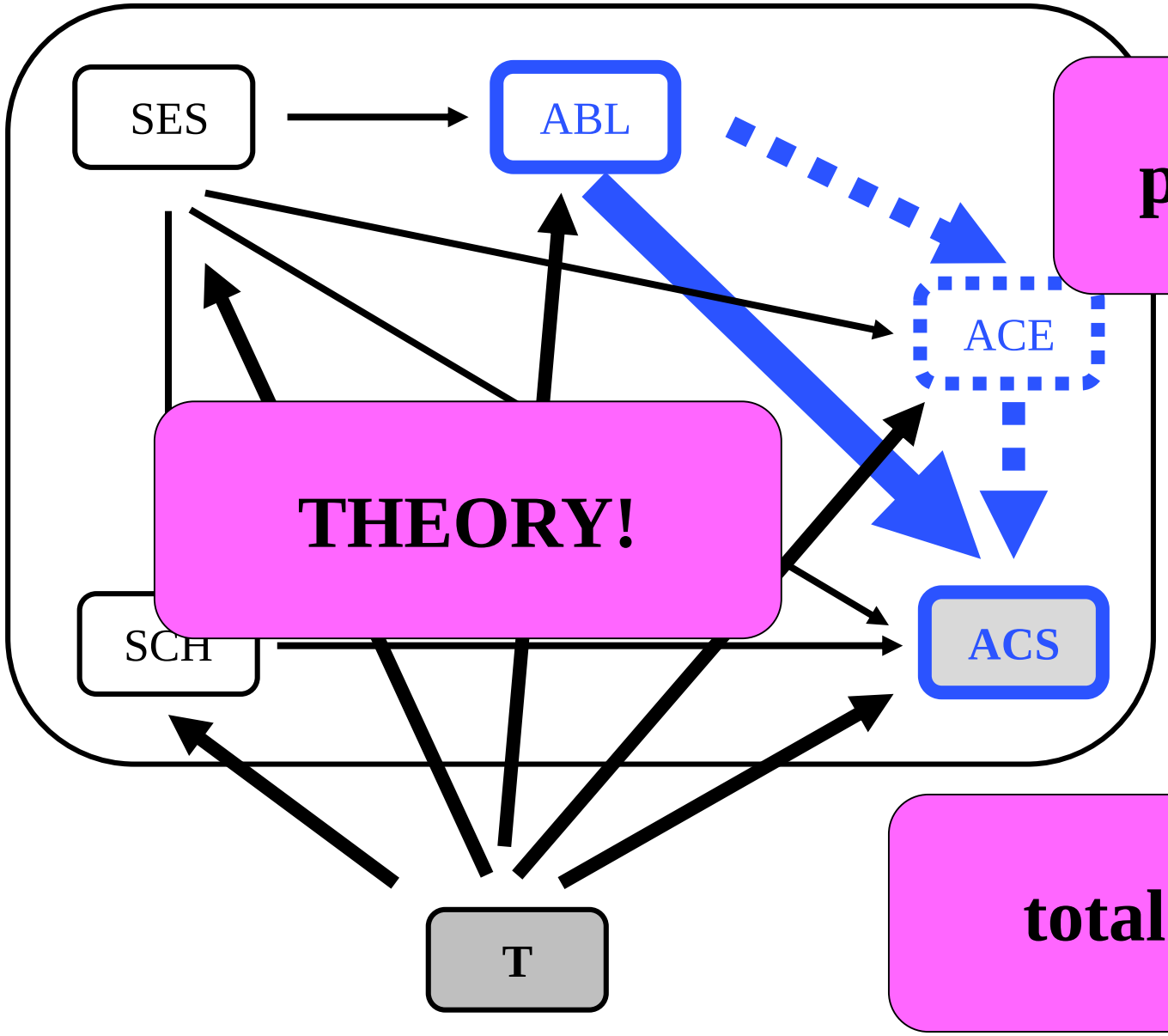


partial effects?



partial effects?

total effect?



partial effects?

total effect?

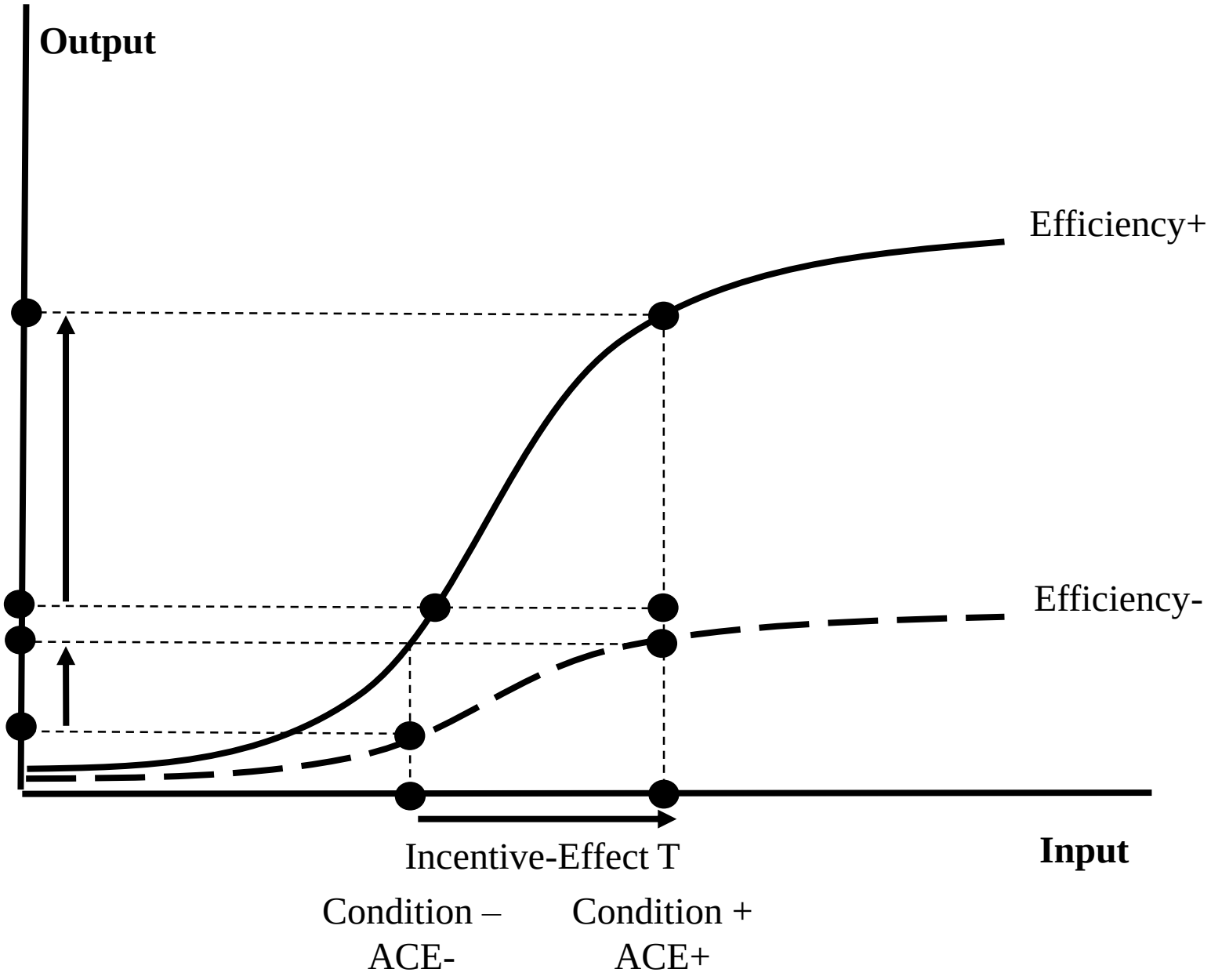
Relations of input, ability, efficiency of learning and achievement as output

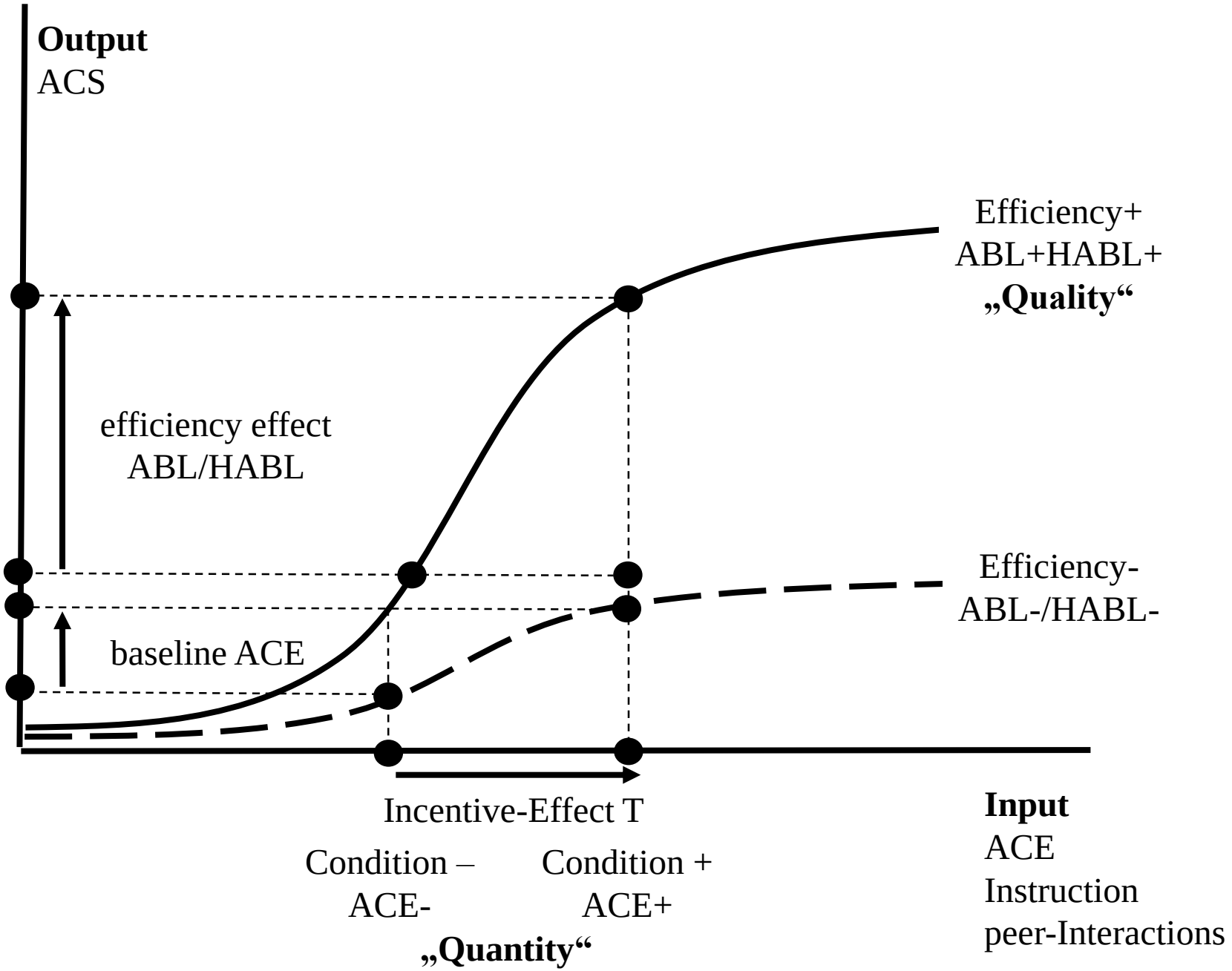
General learning function

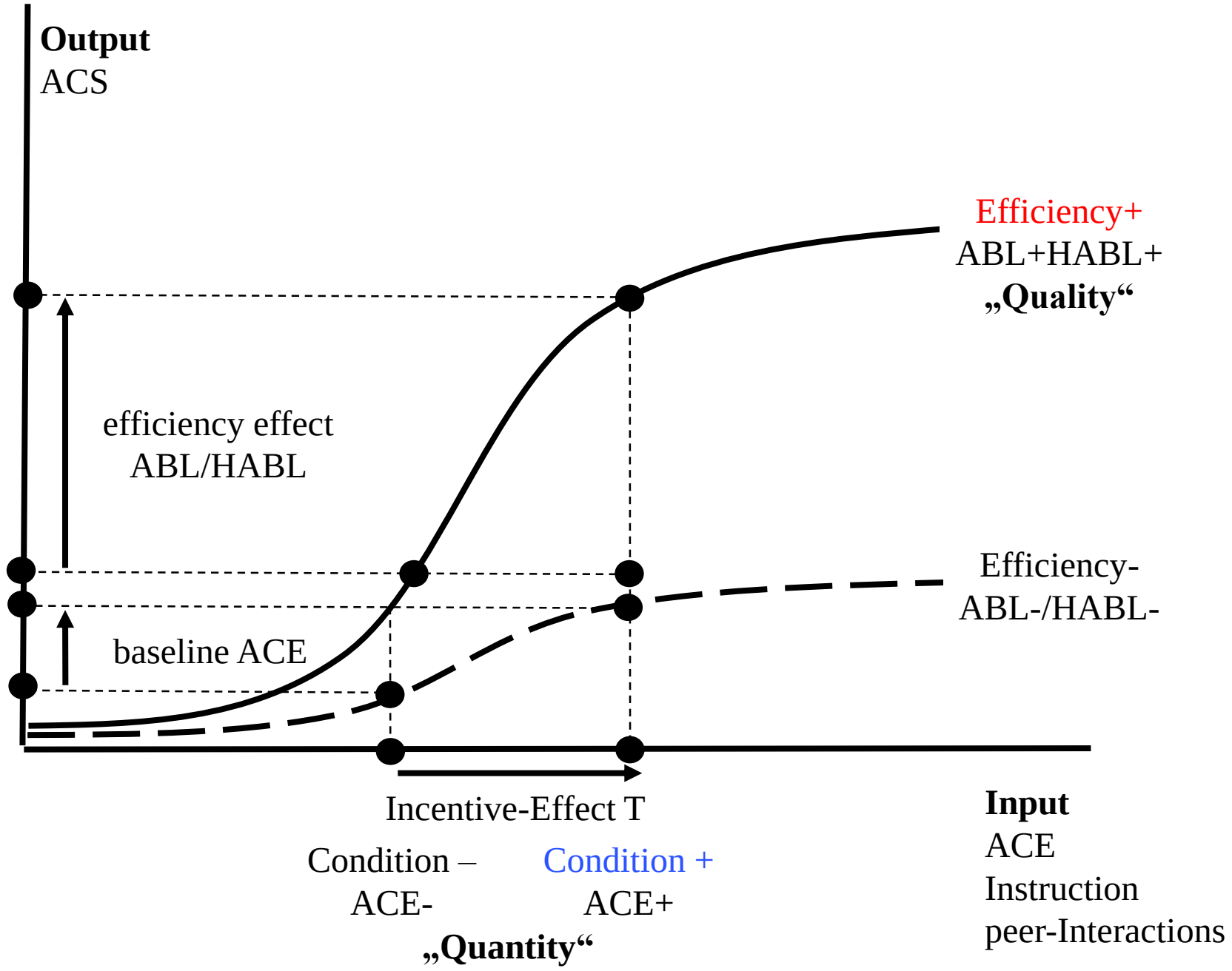
Backgroun

Conditions and Efficiency of Learning

Learning as **TOTAL** result of **conditions** and **efficiency**


Output
Efficiency+
Efficiency-
Input
Incentive-Effect T
Condition –
ACE-
Condition +
ACE+


Output
ACS
Efficiency+
ABL+HABL+
„Quality“
efficiency effect
ABL/HABL
Efficiency-
ABL-/HABL-
baseline ACE
Incentive-Effect T
Condition –
ACE-
Condition +
ACE+
„Quantity“
Input
ACE
Instruction
peer-Interactions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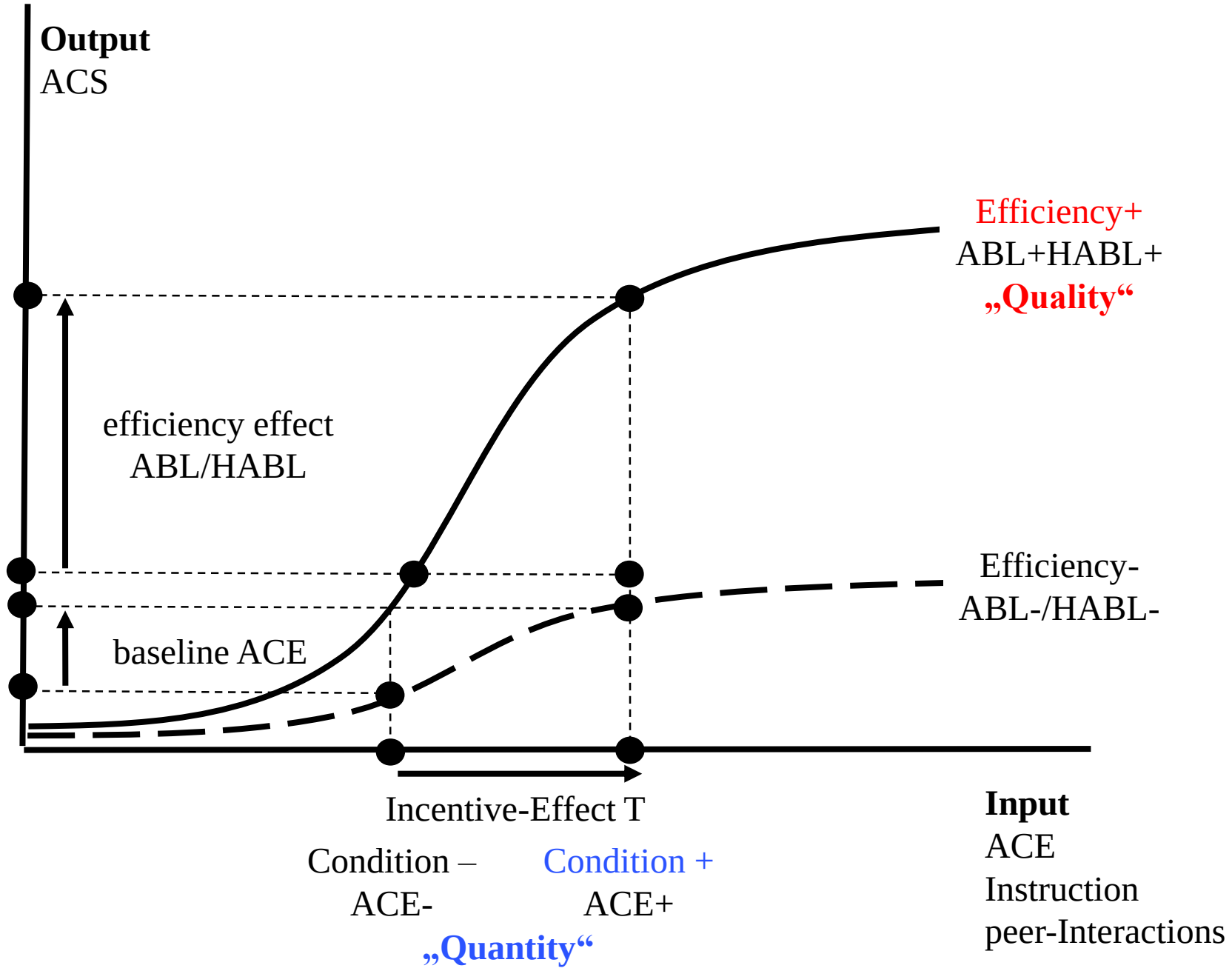
Output
ACS
Efficiency+
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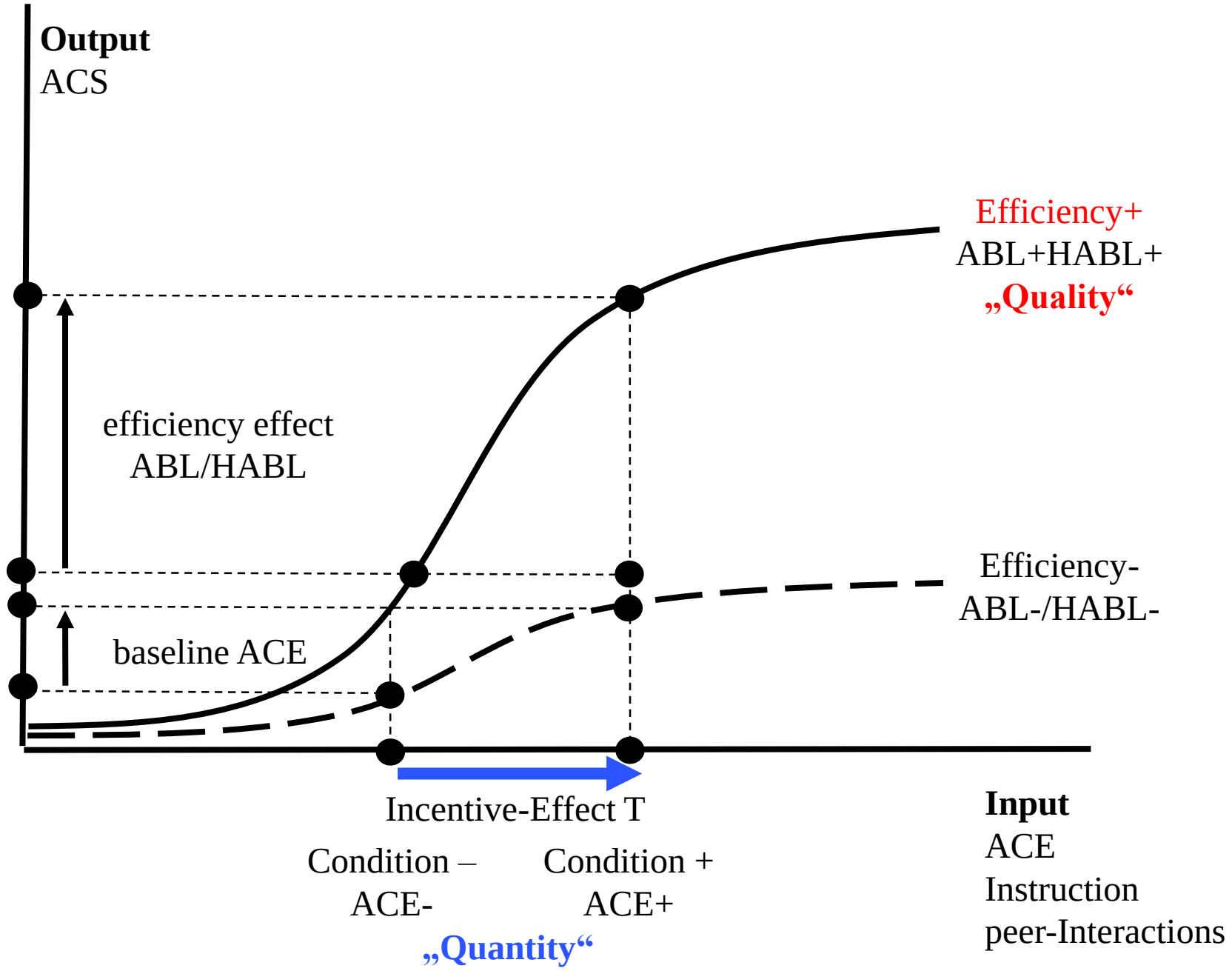
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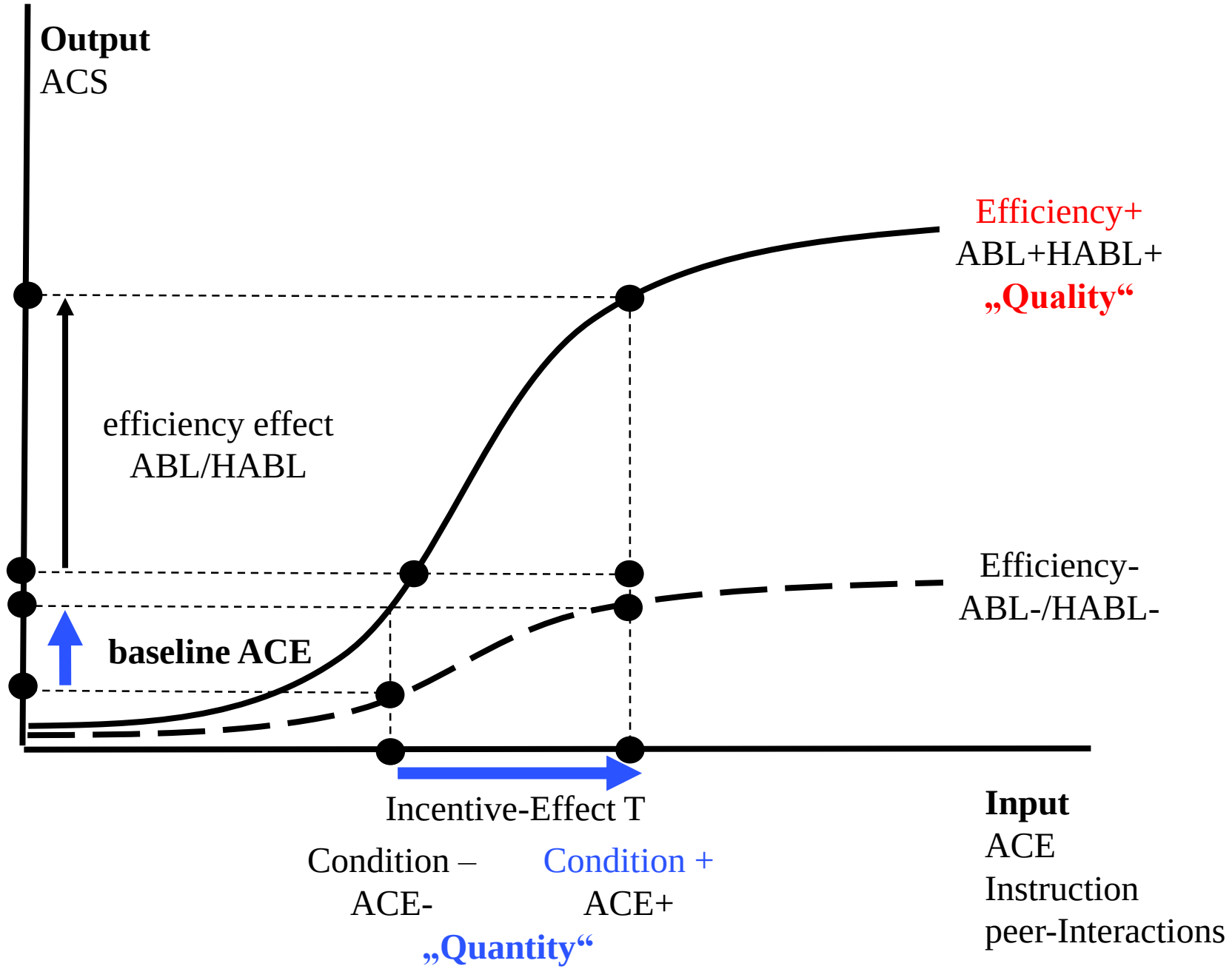
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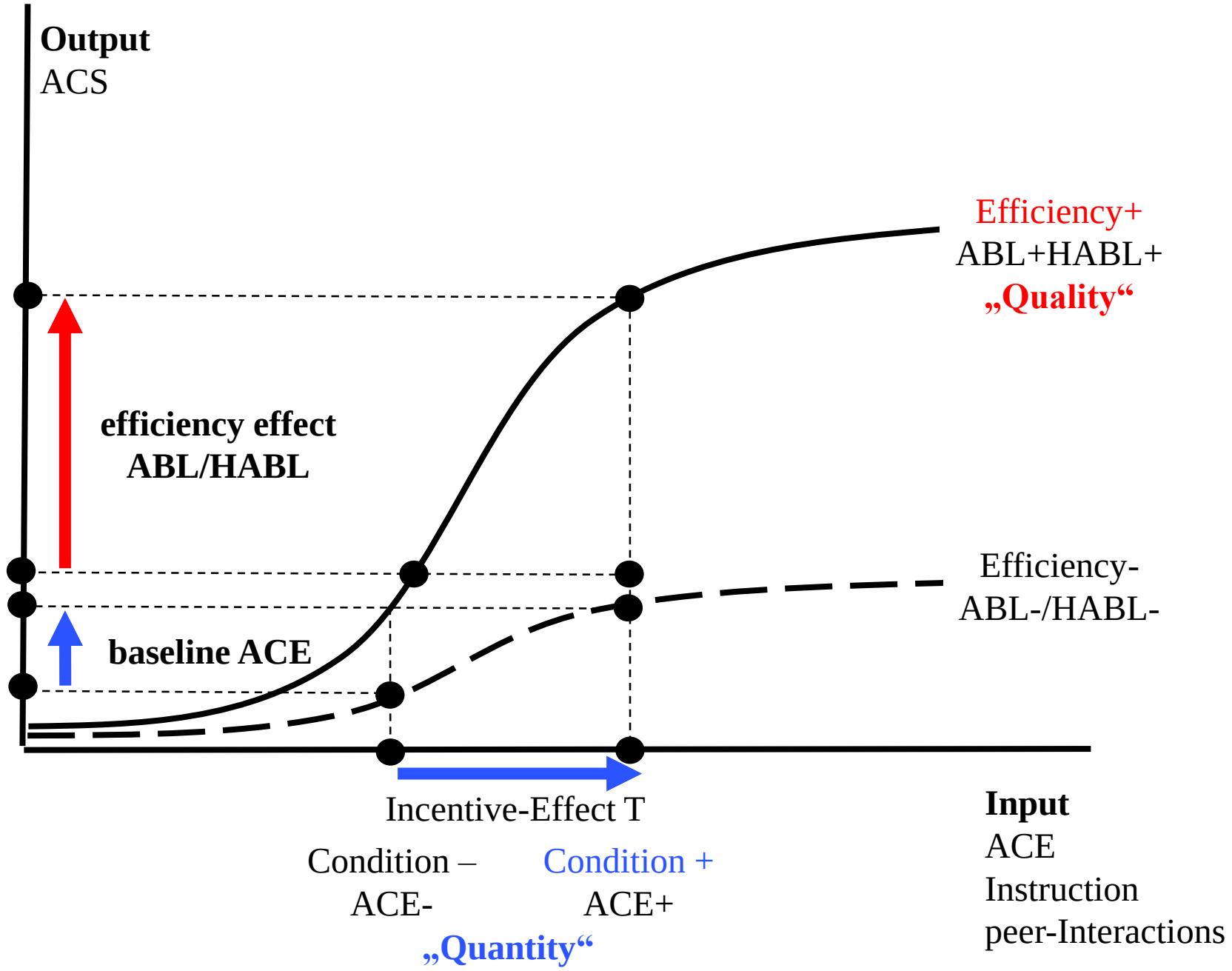
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ACE-
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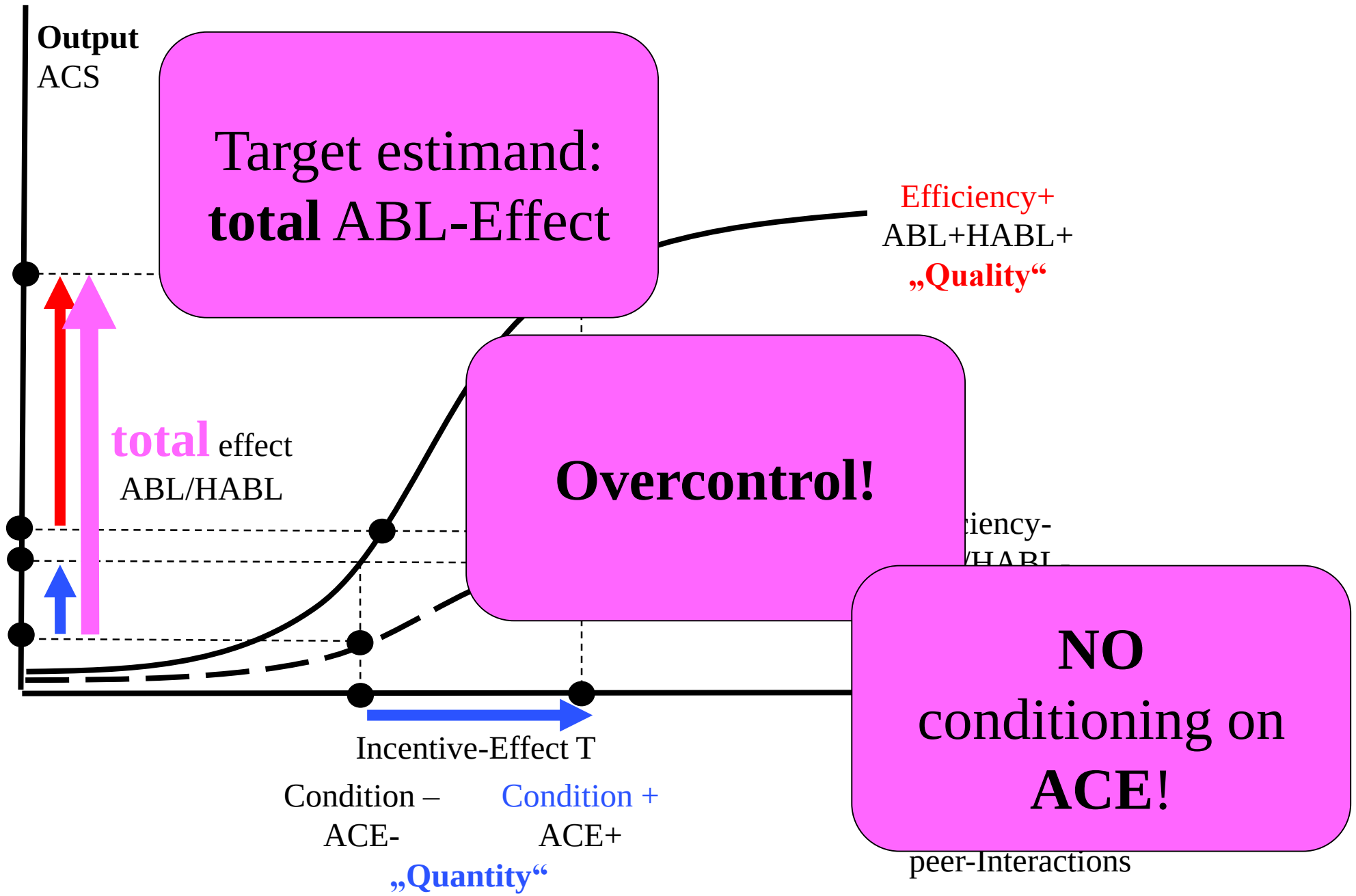
Output
ACS
Target estimand:
total ABL-Effect
Efficiency+
ABL+HABL+
„Quality“
total effect
ABL/HABL
Overcontrol!
iency-
/HABL
NO
conditioning on
ACE!
Incentive-Effect T
Condition –
ACE-
Condition +
ACE+
„Quantity“
peer-Interactions

... and THIS was (therefore) OUR estimand/replicandum!

Als erklärende Bedingung für die Leistungen in der Sekundarstufe werden gezielt die kognitiven Fähigkeiten verwendet, individuell wie als Kontext-Merkmal, und nicht die Leistungen vorher in der Grundschule. Denn darum geht es in den Begründungen für die Differenzierung: Dass sich damit die latenten *kognitiven* Fähigkeiten entfalten können, auch unabhängig davon, was bis dahin und aktuell an Leistungen gezeigt worden ist. (**ES 2020: 190**)

Cognitive abilities are specifically used as explanatory condition for achievement in secondary school, both individually and as a contextual feature, and **not** the achievement beforehand in elementary school. For this is what the theoretical arguments for differentiation are about: that latent cognitive abilities can unfold, also **independently** of what has been shown up to then and currently in terms of achievement. (**ES 2020: 190**)

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Empirical Comparisons

1. Mediation

(unconditional T-Effect)

Analyses ES 2020

		MoAbiT	1	2	3	4	5	6
SES: Socioeconomic background	SES	+		**0.67**	**0.42**	**0.40**	**0.40**	**0.40**
NSES: Level SES school class (mean) HSES: Homogeneity SES school class (sd^{-1}) Interaction NSES and HSES	NSES	+			**6.73**	**4.56**	**2.39**	1.14
	HSES				**2.32**	**1.42**	0.58	0.26
	NSES*HSES				**-4.96**	**-3.06**	-1.48	-0.73
ACE: Prior achievement ABL: General cognitive abilities	ACE					***	***	***
	ABL	+				**1.59**	**1.43**	**1.43**
NABL: Level ABL school class (mean) HABL: ABL school class (sd^{-1}) Interaction NABL and HABL	NABL	+					**2.19**	**1.46**
	HABL	+					**1.01**	0.75
	NABL*HABL	+					-1.58	-1.22
GYM: School Type	GYM	+						**0.51**
T: Stringency Differentiaton	T(3)	≥0	**0.29**	**0.26**	**0.14**	**0.15**	**0.14**	**0.14**

SHIFT from **SSES** to **SABL**

„correcting replication“!

T-Effect (unconditional)

positive T-Effect **remains!**

		MoAbiT	1	2	3	4	5	6
SES: Socioeconomic background	SES	+					**0.40**	
NSES: Level SES school class (mean) HSES: Homogeneity SES school class (sd^{-1}) Interaction NSES and HSES	NSES	+					**2.39**	
	HSES	+					0.58	
	NSES*HSES	0					-1.48	
ACE: Prior achievement ABL: General cognitive abilities	ACE	***					***	
	ABL	+					**1.43**	
NABL: Level ABL school class (mean) HABL: ABL school class (sd^{-1}) Interaction NABL and HABL	NABL	+					**2.19**	
	HABL	+					**1.01**	
	NABL*HABL	+					-1.58	
GYM: School Type	GYM	+						
T: Stringency Differentiaton	T(3)	≥0					**0.14**	

		MoAbiT	1	2	3	4	**ES2020**	6
SES: Socioeconomic background	SES	+					**0.40**	
NSES: Level SES school class (mean) HSES: Homogeneity SES school class (sd^{-1}) Interaction NSES and HSES	NSES	+					**2.39**	
	HSES	+					0.58	
	NSES*HSES	0					-1.48	
ACE: Prior achievement ABL: General cognitive abilities	ACE	***					***	
	ABL	+					**1.43**	
NABL: Level ABL school class (mean) HABL: ABL school class (sd^{-1}) Interaction NABL and HABL	NABL	+					**2.19**	
	HABL	+					**1.01**	
	NABL*HABL	+					-1.58	
GYM: School Type	GYM	+						
T: Stringency Differentiaton	T(3)	≥0					**0.14**	

„Replication“ NN 2022

		MoAbiT	1	2	3	4	**ES2020**	6
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NSES: Level SES school class (mean) HSES: Homogeneity SES school class (sd^{-1}) Interaction NSES and HSES	NSES	+					**2.39**	
	HSES	+					0.58	
	NSES*HSES	0					-1.48	
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	HABL	+					**1.01**	
	NABL*HABL	+					-1.58	
GYM: School Type	GYM	+						
T: Stringency Differentiaton	T(3)	≥0					**0.14**	

	MoAbiT	1	2	3	4	**ES2020**	**NN2022**
SES: Socioeconomic background							
SES	+					**0.40**	0.06
NSES: Level SES school class (mean) HSES: Homogeneity SES school class (sd^{-1}) Interaction NSES and HSES							
NSES	+					**2.39**	0.95
HSES	+					0.58	0.26
NSES*HSES	0					-1.48	-0.63
ACE: Prior achievement ABL: General cognitive abilities							
ACE						***	**0.55**
ABL						**1.43**	**0.13**
NABL: Level ABL school class (mean) HABL: ABL school class (sd^{-1}) Interaction NABL and HABL							
NABL						**2.19**	**1.05**
HABL	+					**1.01**	0.63
NABL*HABL	+					-1.58	-0.78
GYM: School Type							
GYM	+						
T: Stringency Differentiaton							
T(3)	≥0					**0.14**	0.05

unconditional T-Effect **disappears** with control of ACE ...

OVERCONTROL!

... but even then**: NOT** negative!

2. Moderation

(conditional HABL-Effect)

Constructs	**ES 2022 without ACE**	**ES 2022 with ACE**
T(3)	-1.22	-1.20
SES	**x**	**x**
T*SES	**x**	**x**
T*NSES	**x**	**x**
T*HSES	**x**	**x**
T*NSES*HSES	**x**	**x**
ACE	***	**x**
ABL	**x**	**x**
T*ABL	-0.14	-0.12
T*NABL	**3.18**	**2.27**
T*HABL	**2.49**	**1.82**
T*NABL*HABL	**-4.14**	**-3.04**

Constructs	**ES 2022 without ACE**	**ES 2022 with ACE**
T(3)	-1.22	-1.20
SES	**x**	**x**
T*SES	**x**	**x**
T*NSES	**x**	**x**
T*HSES	**x**	**x**
T*NSES*HSES	**x**	**x**
ACE	***	**x**
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T*ABL	-0.14	-0.12
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Constructs	ES 2022 without ACE	ES 2022 with ACE
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T*NSES	x	x
T*HSES	x	x
T*NSES*HSES	x	x
ACE	***	x
ABL	x	x
T*ABL	-0.14	-0.12
T*NABL	**3.18**	**2.27**
T*HABL	**2.49**	**1.82**
T*NABL*HABL	**-4.14**	**-3.04**

Analyses **controlling** for baseline performance in grade 5 yielded **comparable** findings. (**ES 2020: 290**)

Effect of homogenization REMAINS!

Three-way!

... effects disappears in NN **only**, because the **empirical** estimand was **changed**: from three-way to two-way

Threeway-Interaction

Strictness of ABL-Tracking
Level of ABL in schoolclass
Homogeneity of ABL in schoolclass

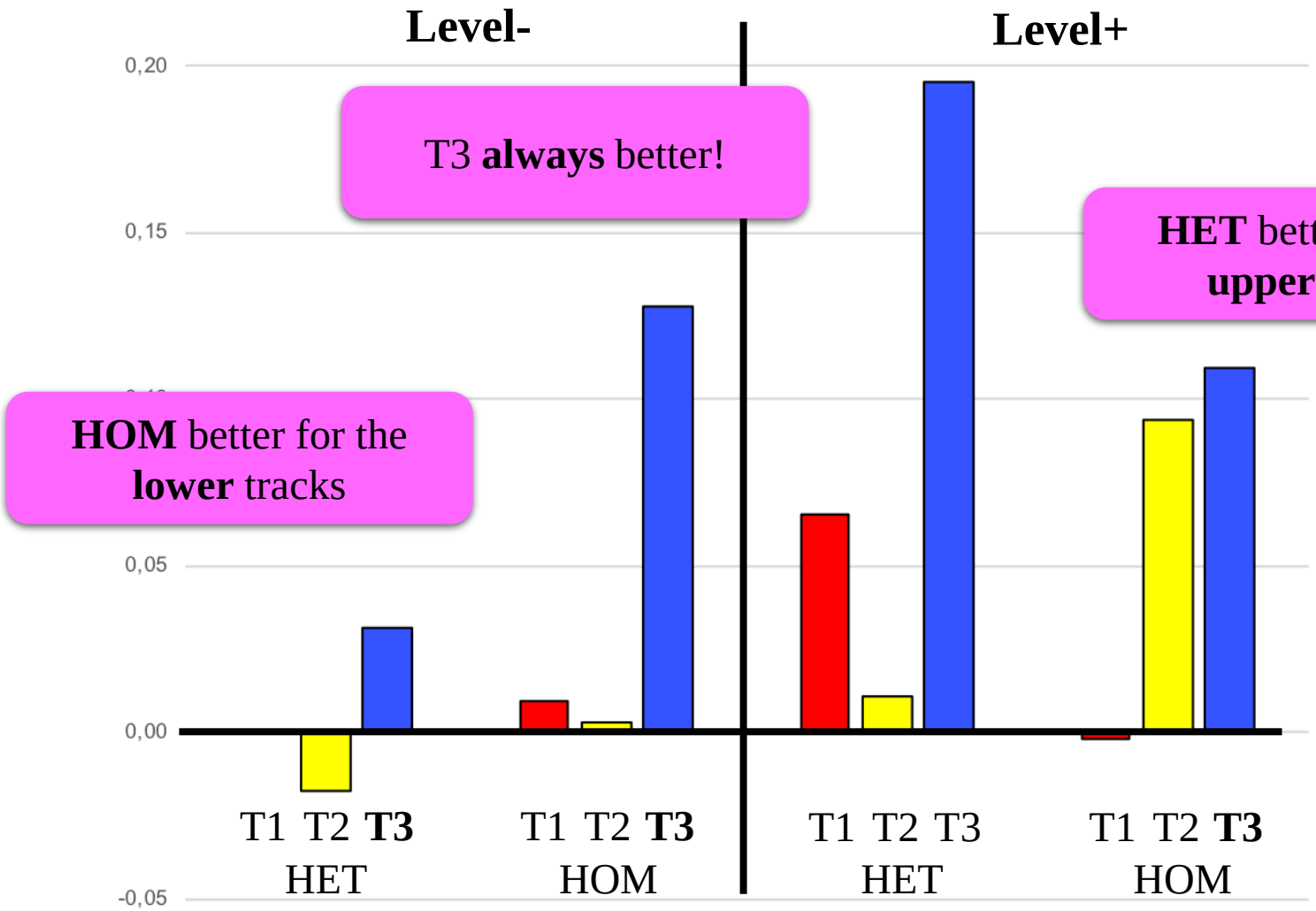
T*NABL*NABL

Graphical illustration

theoretical foundation:

Ability-Treatment Interaction (ATI)

Effects of T*NABL*HABL



T3 **always** better!

HET better for the **upper** tracks

HOM better for the **lower** tracks

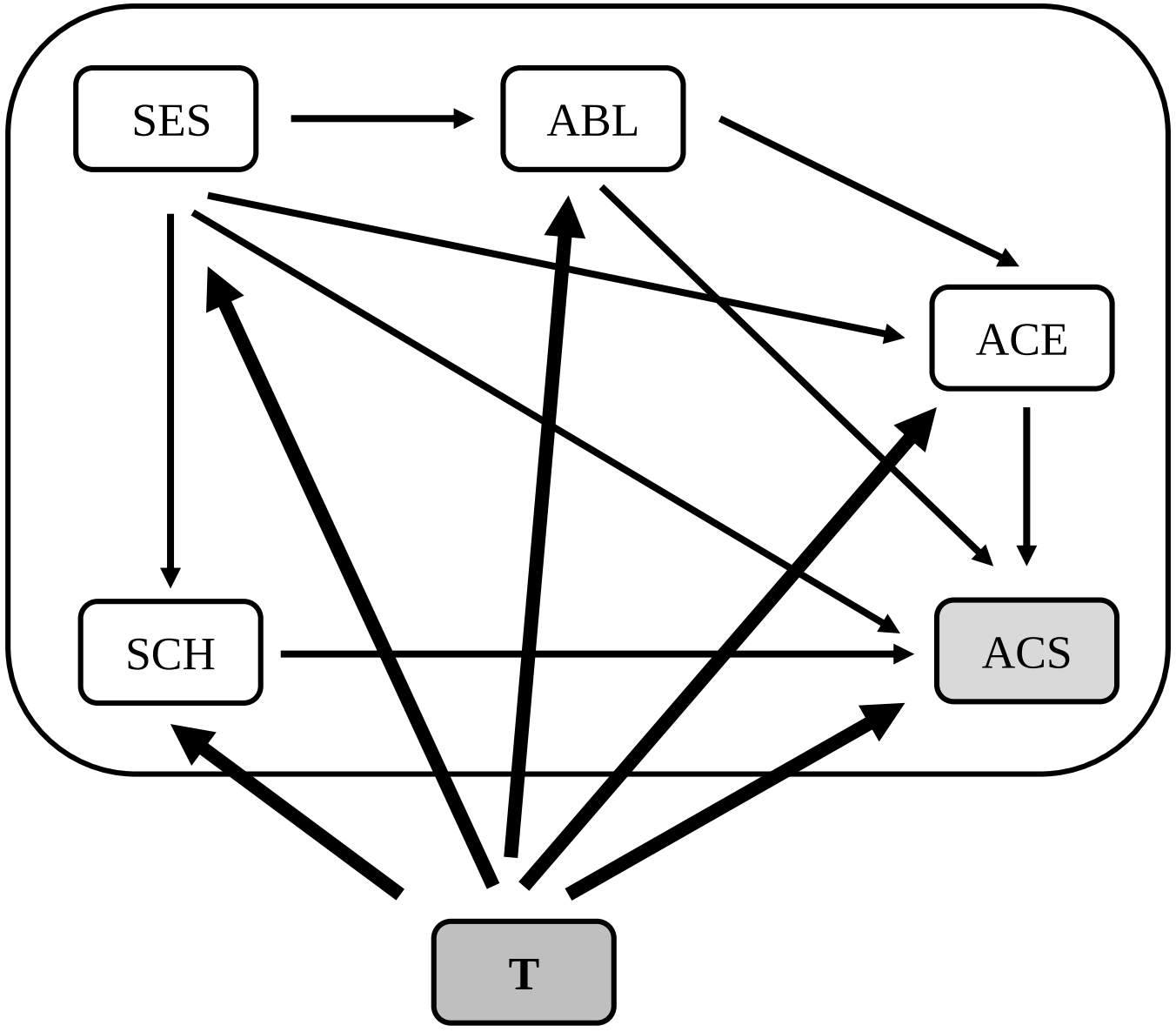
Correcting replication

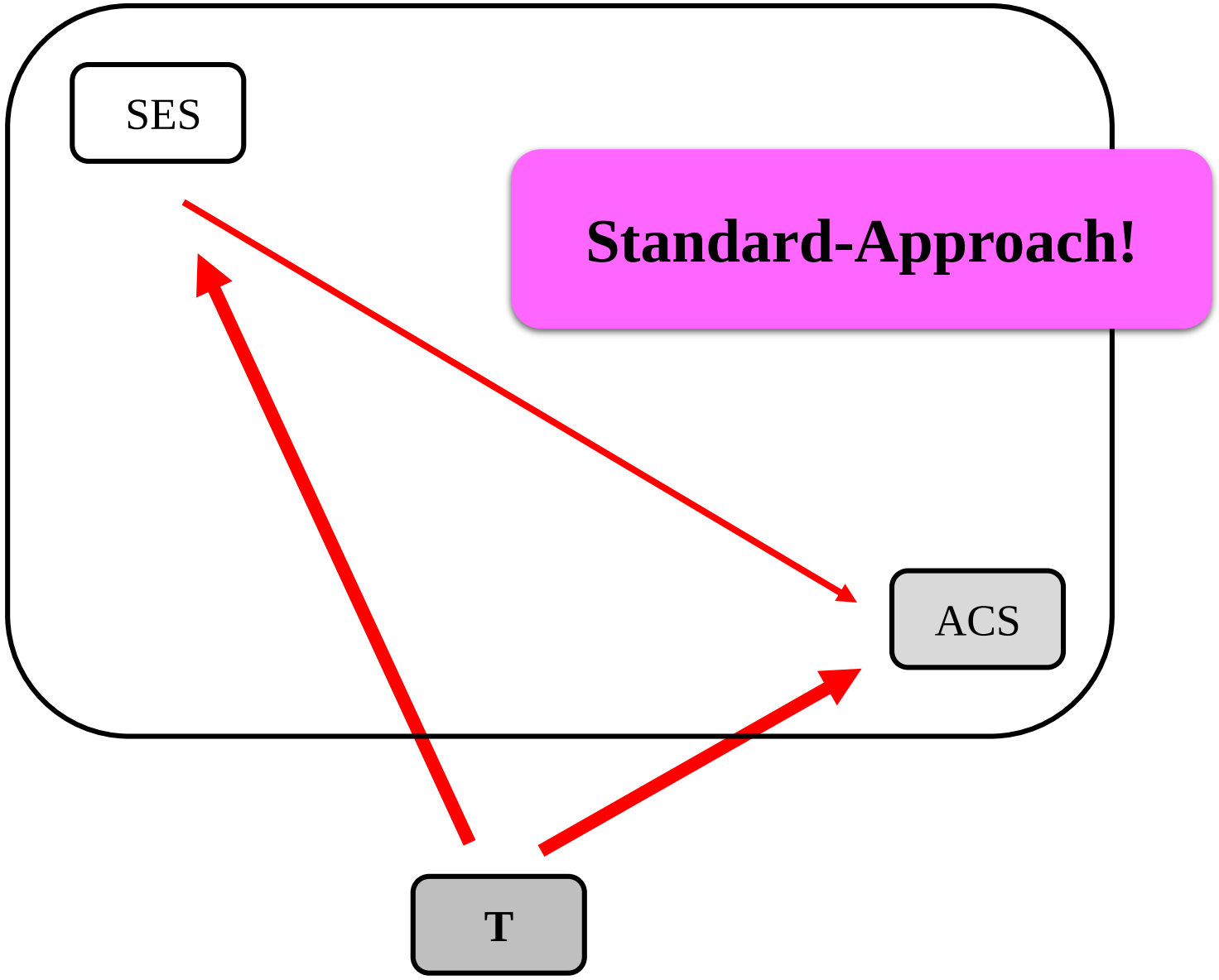
... the critiques and replications of NN and others were a great step in a further **clarifying** this longstandig dispute

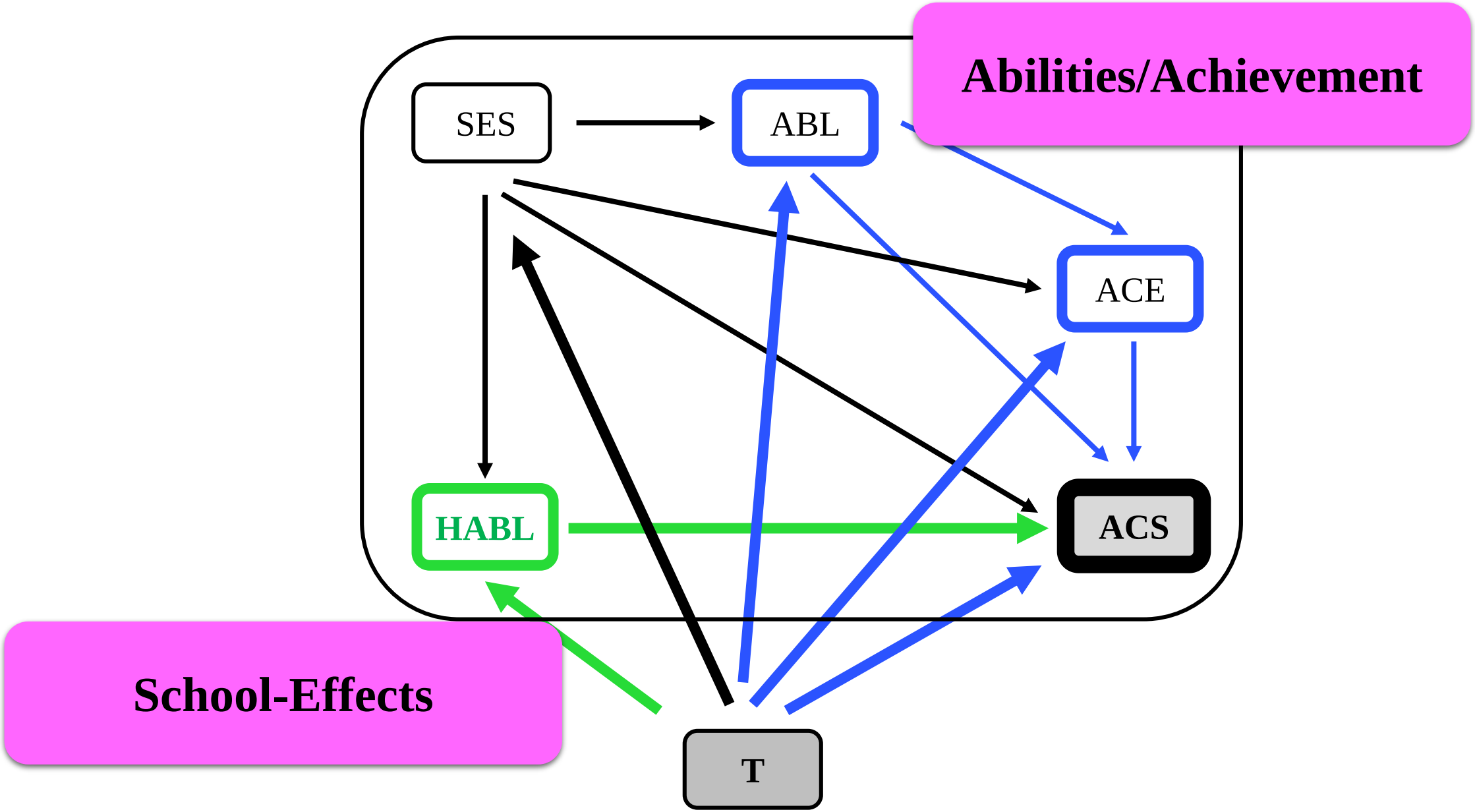
... even if they were largely wrong, distorting and at least partly ignorant of what could be found in the originals.

Estimands ar
The Dispute
Theory
Re-Corrections
Conclusions

... and don't forget what was before:


SES
ABL
ACE
SCH
ACS
T


SES
Standard-Approach!
ACS
T


Abilities/Achievement
SES
ABL
ACE
HABL
ACS
T
School-Effects

Addenda

1. Threeway- Interaction

Threeway-Interaction

Strictness of ABL-Tracking
Level of ABL in schoolclass
Homogeneity of ABL in schoolclass

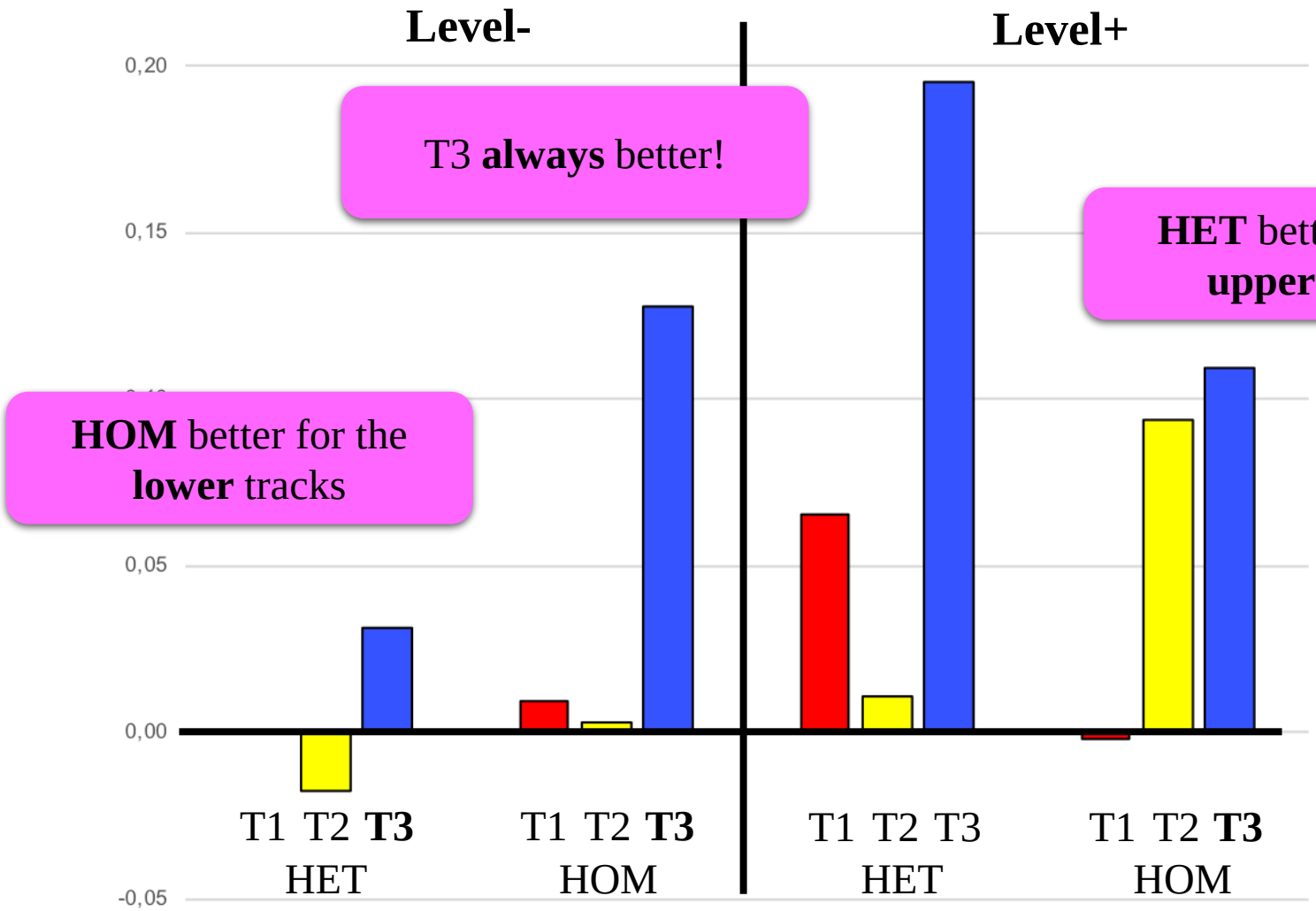
T*NABL*NABL

Graphical illustration

theoretical foundation:

Ability-Treatment Interaction (ATI)

Effects of T*NABL*HABL



T3 **always** better!

HET better for the **upper** tracks

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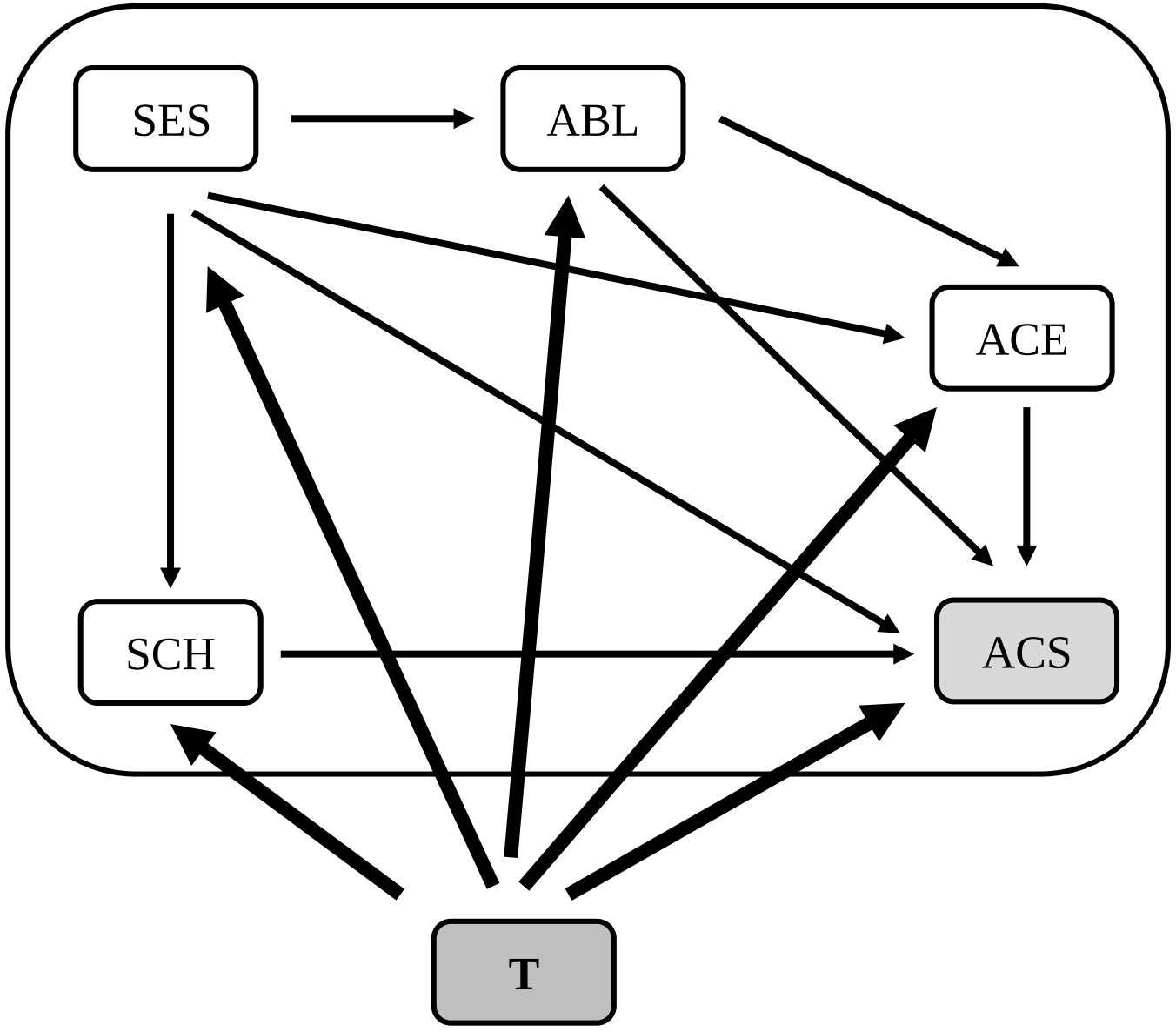
Correcting replication

2. The Standard-Position
A Reminder


SES
ABL
ACE
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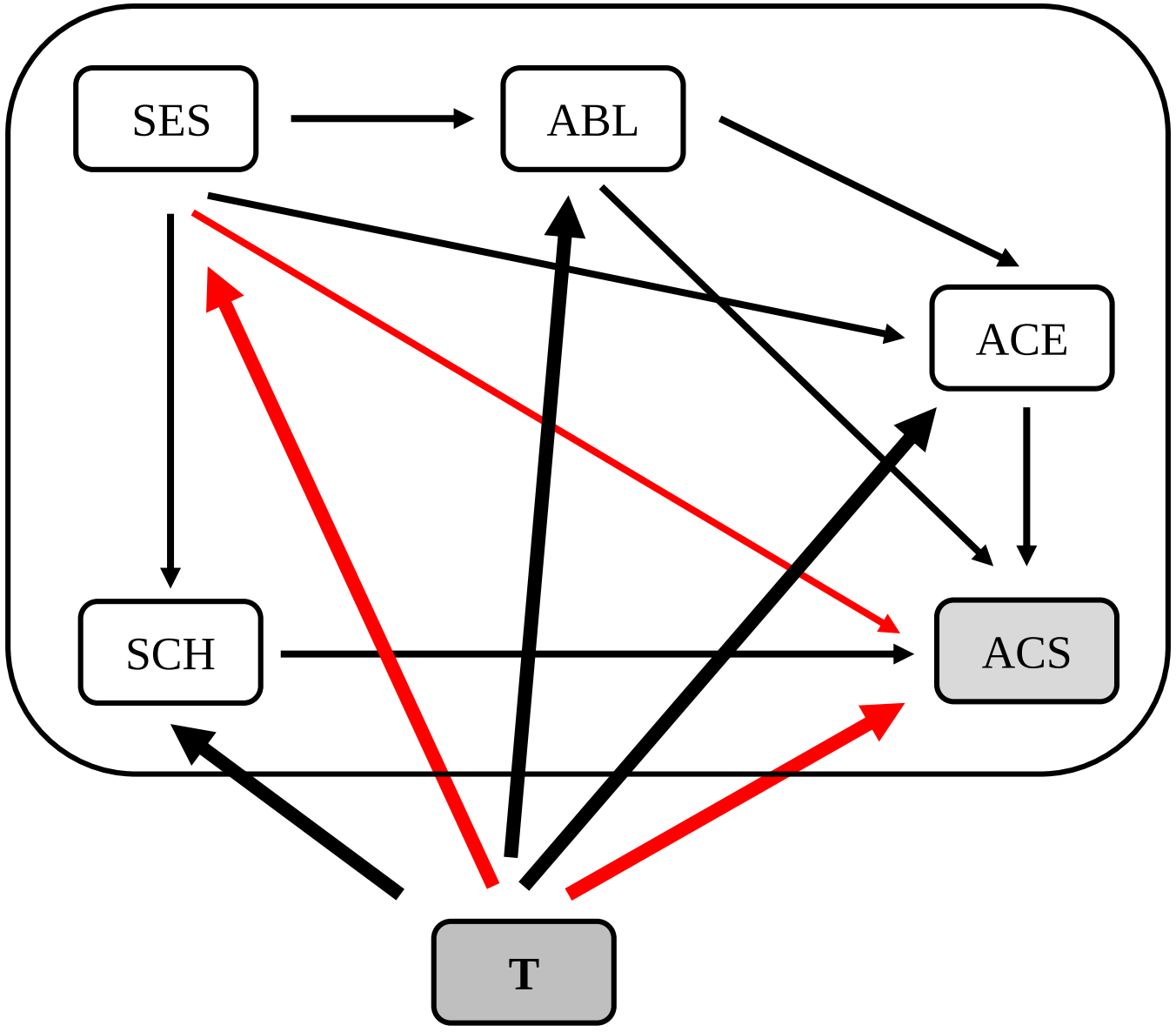
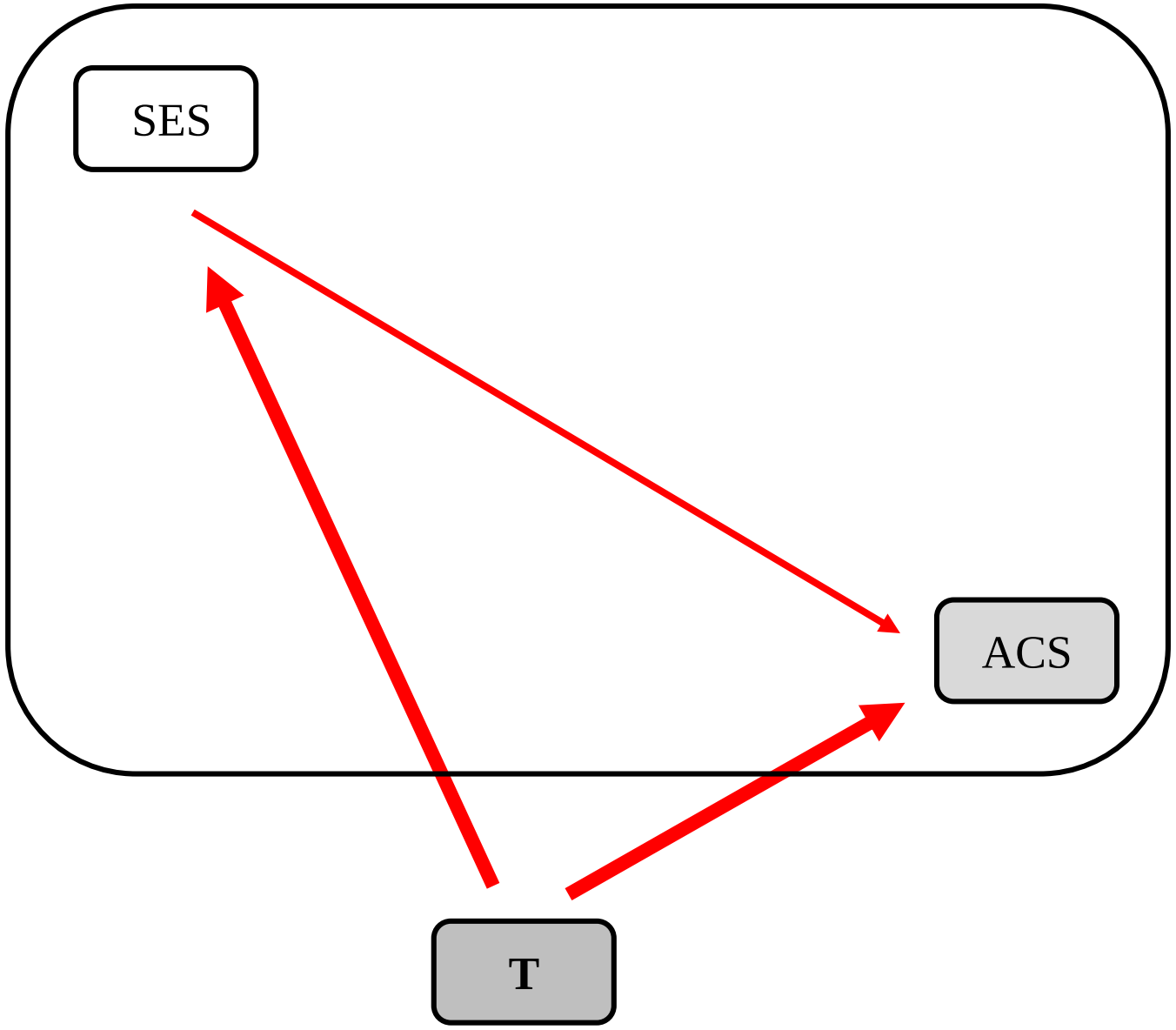
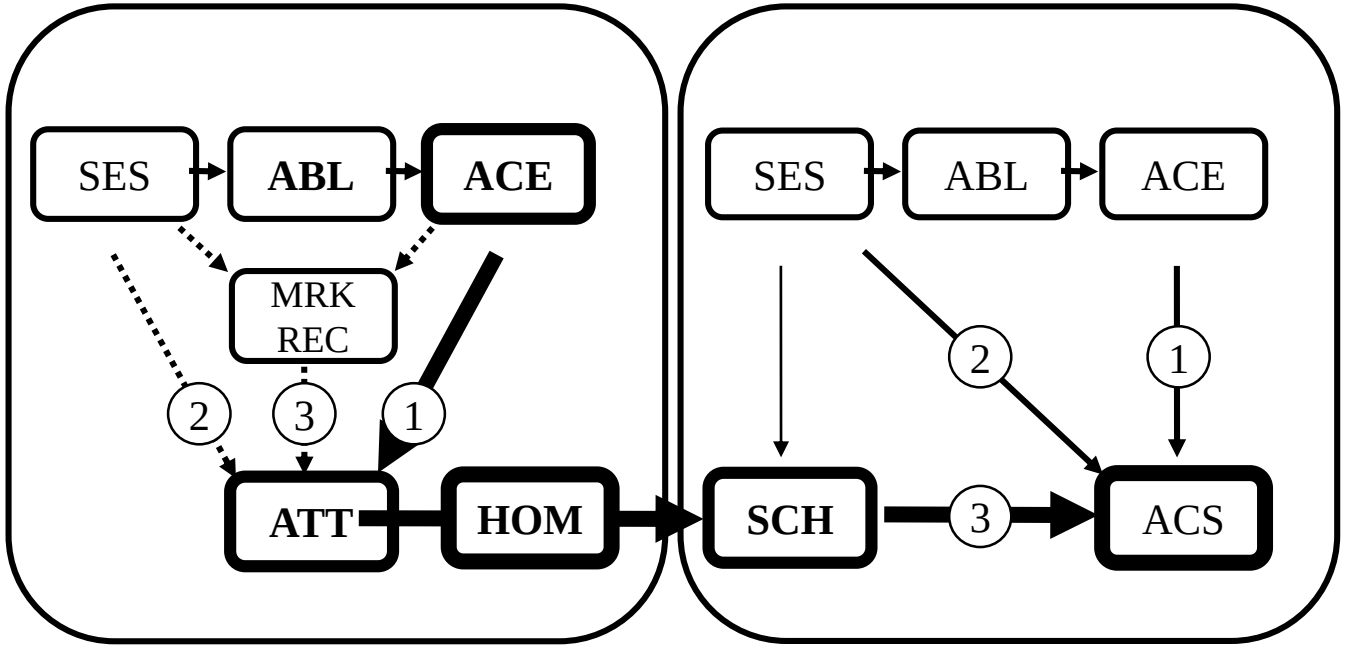
ACS
T


SES
ABL
ACE
SCH
ACS
T


SES
ACS
T

System-Effects Ability-Tracking

Sorting and Attainment | Achievement

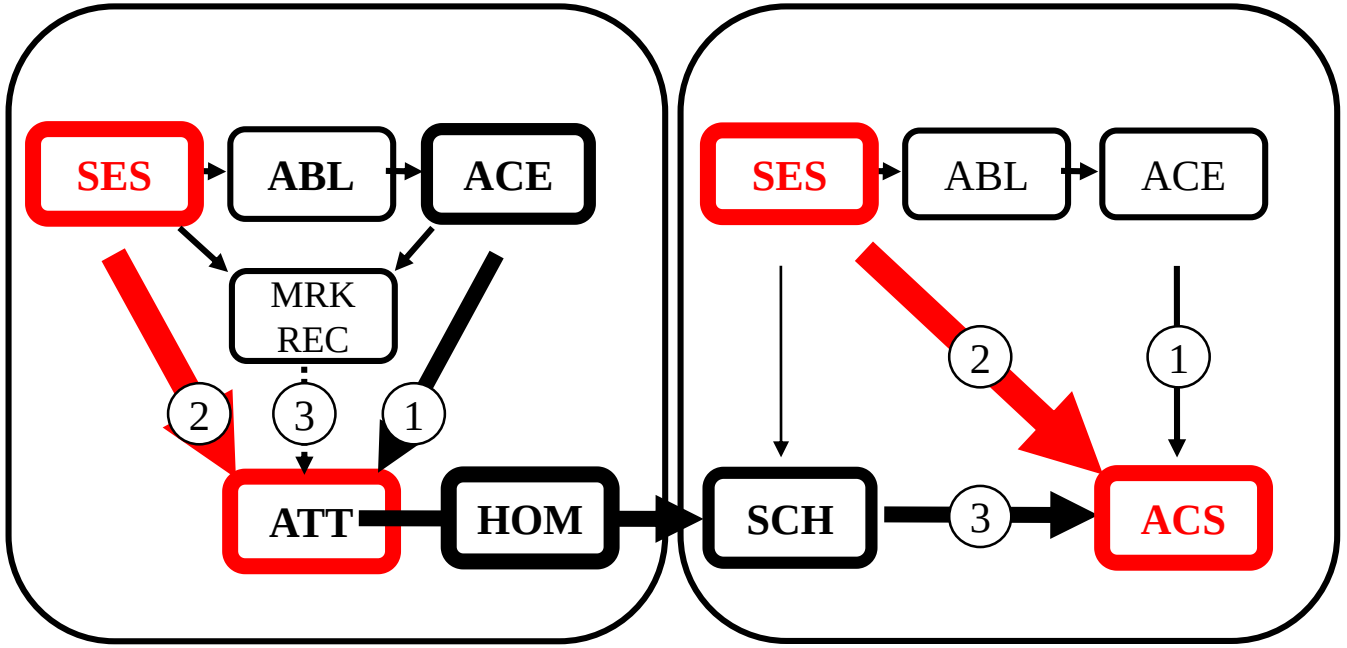


SES: Social background	REC: Recommendations
ABL: Abilities	ATT: Attainment
ACE: Achievement primary school	SCH: Schools
MRK: Marks	ACS: Achievement secondary school

Sorting/Attainment | Structuration | Achievement

System-Effects Ability-Tracking

Sorting and Attainment | Achievement



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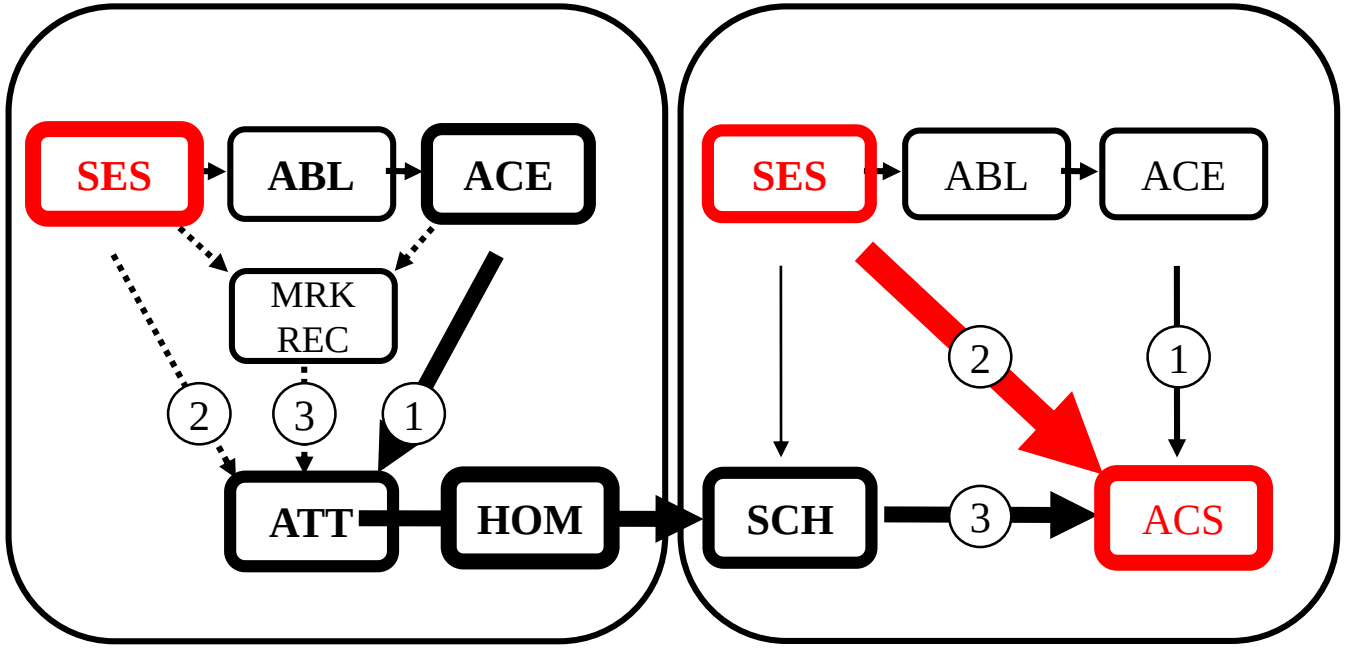
System-Effects Ability-Tracking

Sorting and Attainment | Achievement



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Sorting/Attainment | Structuration | Achievement

3. Ability- or Achievement-Tracking?

	Ability-Tracking	Achievement-Tracking
T3 (unconditional)	**0.19**	0.01
T3 (konditional)	-0.99	
T3*SES	-0.02	
T3*NSES	-0.54	0.21
T3*HSES	-0.56	-0.05
T2*NSES*HSES	0.51	0.64
T3*ABL	-0.14	-0.07
T3*NABL	**2.93**	-0.18
T3*HABL	**2.46**	0.24
T3*NABL*HABL	**-4.09**	-0.13
T3*GYM	0.22	**0.30**
c	-2.23	
R^2: Level 1	0.14	
R^2: Level 2	0.88	
N: SuS	2636	2636
N: Klassen	313	313

ACH is NOT the same

Explains why all these substitues don´t work!

4. The Other Points

The other points

10 Points

1. No generalization to the full international variance in systems
2. NEPS: case numbers too small and biased distributions
3. Wrong operationalization of class composition („leave-i-out“)
4. Wrong and misleading mediation-analyses
5. Interaction of cognitive niveau and homogeneity
6. Control of school-types
7. Abilities and achievements as equivalents
8. No control of achievements before
9. Primary System-Effects
10. Two-way- instead of three-way-interactions

The other points

10 Points

... but conditional on **implementation** of Ability-Tracking!

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The other points

NEPS: case numbers too small and biased distributions

10 Points

... small, indeed, but **not** biased!

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Wrong operationalization of class composition („leave-i-out“)

wrong application of „leave-i-out“-rule for the **given** case

ACS as dependent variable, but **ABL** as contextual variable

„leave-i-out“ applies only for peer-effects, but **no**t for curriculum/instruction

The other points

... wrong and misleading mediation-analyses

... **no proof** for (unconditional) HABL-effects

10 Points

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2. NEPS: case numbers too small and biased distr
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... **arbitrary** change of target quantity:

„correcting replication“ vs. proof of specific unconditional effects

... **misconception** of what mediation means for **Systemeffects**

... **change** of general effects and moderation

The other points

10 Points

... two-way-interaction of NABL*NABL superfluos and misleading

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5. **Interaction of cognitive niveau and homogeneity**
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... **no** way! (Aptitude-treatment-interaction)

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... GYM **not** considered

... arbitrary omission of a central aspect of any differentiated system (cf. Domina et al. 2019)

The other points

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NO!
(see above)

The other points

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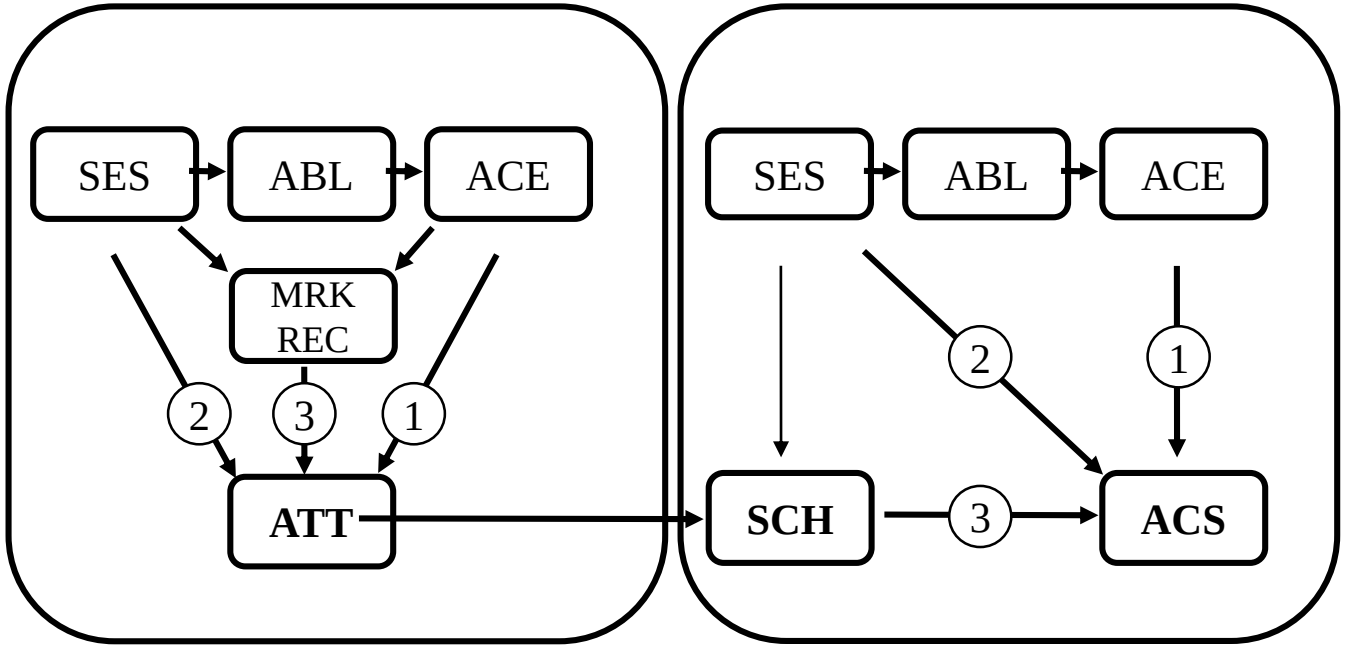
See the scheme of MoAbit

general Relations
(all systems)

Sorting and Attainment | Achievement



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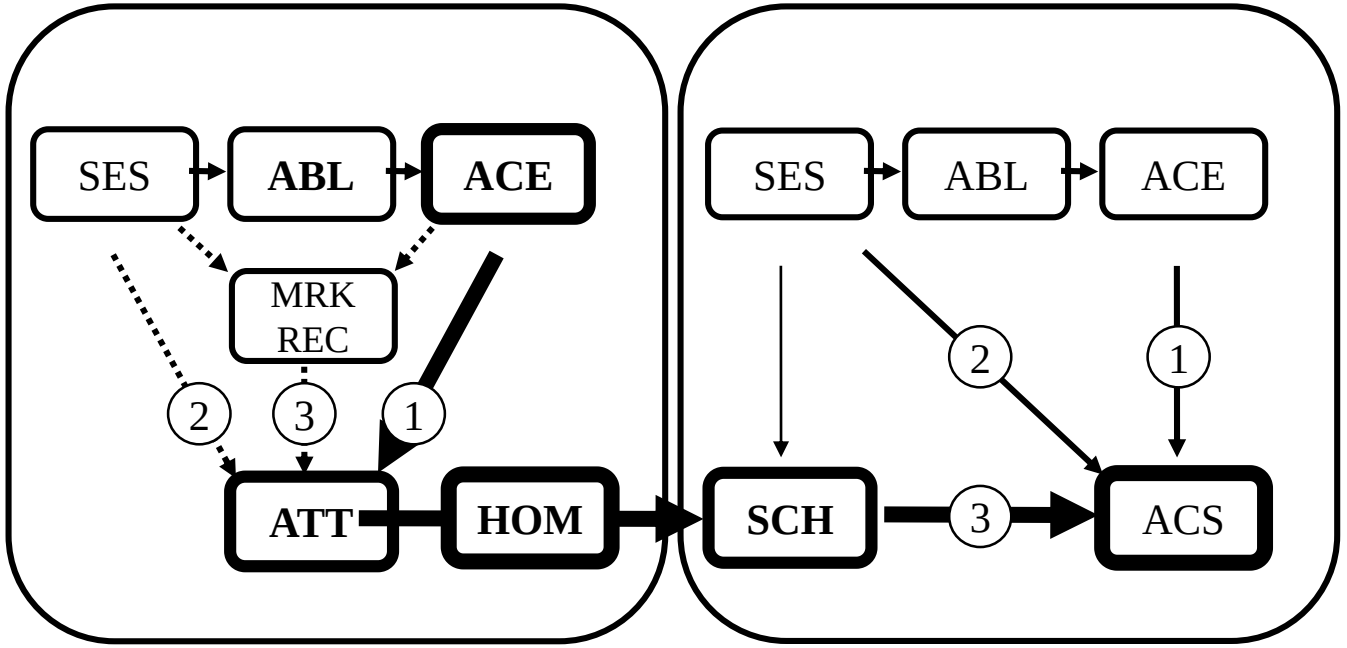
Sorting/Attainment | Structuration | Achievement

System-Effects Ability-Tracking

Sorting and Attainment | Achievement



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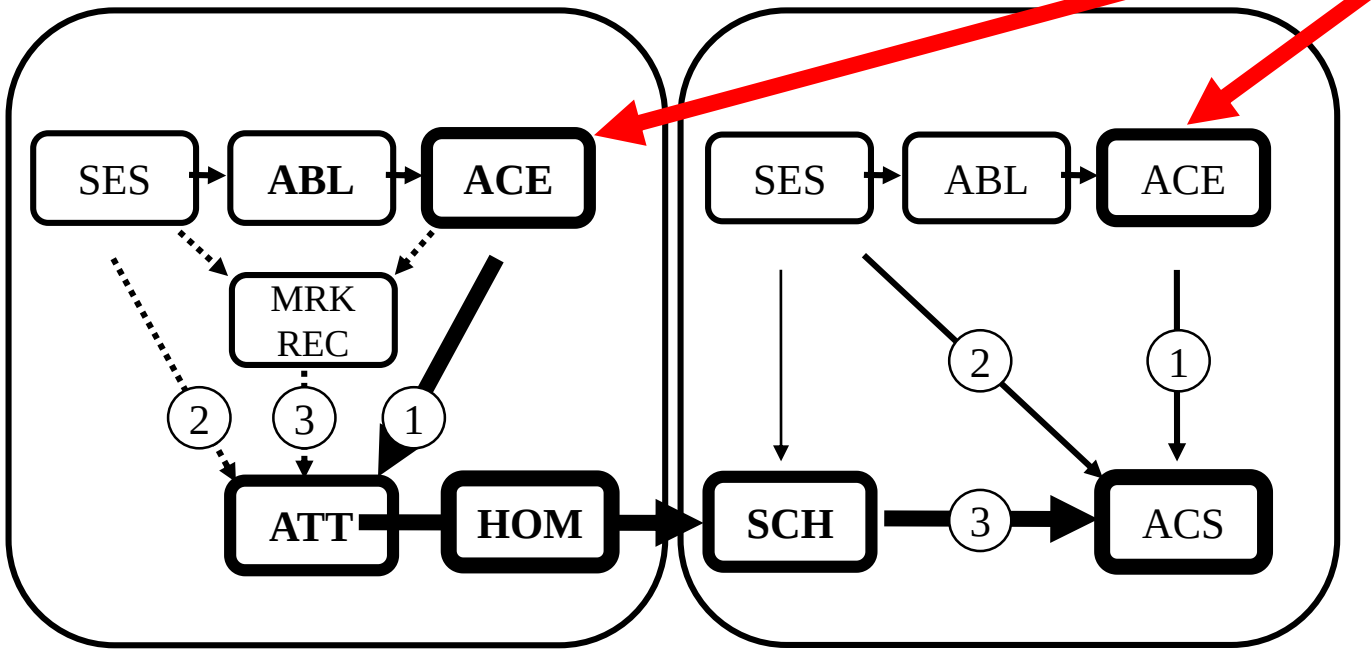
Sorting/Attainment | Structuration | Achievement

System-Effects Ability-Tracking

SAME timepoint

Sorting and Attainment

Achievement



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Threeway-interaction (T*NABL*HABL) „overly complex“, therefore only the two two-way-interactions (T*NABL, T*HABL)

T*HABL-effect disappears!

... **ignorance** of the theoretical foundation (ATI) and arbitrary **distortion** of the decisive empirical estimand