

# Who Benefits from Scientific Entrepreneurship Training?

*State of Evidence and Way Forward — v7*

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**Data.** 8 RCTs (sites 9–14), 1,187 baseline founders (T&E: 427, Evidence-Based: 428, Control: 332), 6 follow-up periods. Outcome:  $\Delta$ SI (scientific intensity change), pivoting,  $\log(\text{sales}+1)$ , dropout. T&E vs Control at periods 1–2 (credible window per attrition analysis). Analysis in R; GenericML (Chernozhukov et al., *Econometrica* 2025); HC1-robust OLS throughout.

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## Part I — What the program does (ATE).

- $\Delta$ SI: ATE  $\approx +0.66$  (P1),  $+0.68$  (P2);  $p < 0.001$  both periods.
  - Pivoting: ATE =  $+0.17$  ( $p = 0.004$ , P1). Training roughly doubles pivot rate.
  - Log sales: ATE  $\approx 0$ , non-significant at P1 and P2.
  - Attrition: treated founders 31 pp less likely to leave before P2 (T=37% vs C=68%); effect significant ( $p < 0.001$ ).
  - **Control arm deteriorates:** 59–65% of control founders have *negative*  $\Delta$ SI at P1–P2 (mean  $-0.34$ ,  $-0.39$ ). Training partly *prevents deterioration*, not only adds. Control arm recovers to near zero only by P4–P5.
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## Part II — Individual-level HTE: null is robust.

480+ cells tested (8 outcomes  $\times$  5 periods  $\times$  12 moderators). Three estimators: manual lasso BLP (D5), 5-learner ensemble (D6), official GenericML 6-learner (D7: lasso, elastic net, ridge, random forest, SVM, XGBoost).

- D5 (480 cells, 250 splits): all null in P1–P2.
- D6 (96 cells, 5 learners): all null.
- D7 (120 cells, 6 learners): two borderline hits on  $\log(\text{sales})$  at P2 (**fei\_resid**:  $\hat{\beta}_2 = 0.19$ ,  $p = 0.036$ ; **months\_working\_1**:  $\hat{\beta}_2 = 0.54$ ,  $p = 0.096$ ). Both disappear under lasso-only spec ( $p > 0.5$  both) — artifacts of better  $B(Z)$ , not real HTE.
- Site-level HTE (OLS within-site + Wald test): ATEs differ across sites ( $\Delta$ SI P1 Wald  $p = 0.0006$ ), but explained by known implementation quality differences (attendance proxy  $r \approx 1$  with site ATE). Replicates Jannace et al. appendix; no new contribution.

**Conclusion.** All 12 moderators (illusion of control, idea aspiration, new ideas, future-event influence, uncertainty perception 6M/2Y, startup phase, tenure, exit probability, idea breadth, planning horizon, FEI residual) are null. SDM training moves all founder types uniformly on  $\Delta$ SI.

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## Part III — Mechanism: $T \rightarrow \Delta$ SI $\rightarrow$ pivot (mediation confirmed).

Baron–Kenny 3-equation test, HC1-robust SEs, controls + site FEs throughout.

Period	Path	$\hat{\beta}$	$p$	ACME	Sobel $p$	% mediated
P1	T $\rightarrow$ $\Delta$ SI (a)	+0.659	< 0.001			
	$\Delta$ SI $\rightarrow$ pivot   T (b)	+0.050	0.002	0.033	0.006	21%
	T $\rightarrow$ pivot   $\Delta$ SI (c')	+0.121	0.006			
P2	T $\rightarrow$ $\Delta$ SI (a)	+0.675	< 0.001			
	$\Delta$ SI $\rightarrow$ pivot   T (b)	+0.058	0.003	0.039	0.009	26%
	T $\rightarrow$ pivot   $\Delta$ SI (c')	+0.112	0.038			

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*Interpretation.* Partial mediation:  $\Delta$ SI explains roughly one-quarter of the training effect on pivoting. A substantial direct effect of treatment on pivoting remains, suggesting a parallel channel (e.g., accountability, peer learning, mentor feedback). No mediation on  $\log(\text{sales})$  — sales are null regardless.

*Literature context.* Camuffo & Gambardella have published pivots as a secondary outcome in three papers but have not formally established the  $T \rightarrow \Delta$ SI  $\rightarrow$  pivot mediation chain:

- *Management Science* 2020 (original): treated pivot 2× more (26 vs 12), secondary outcome, no mediation analysis.
- *SMJ* 2024 (large-scale replication,  $N = 759$ ): nonlinear aggregate effect — trained firms pivot 1–2 times focusedly; no individual-level HTE.
- *Strategy Science* 2024 (Valentine, Novelli, Agarwal): pivot *types* via qualitative + ML coding of 1,600+ interviews; theorization × experimentation produces purposeful pivots. Heterogeneity in pivot quality, not who pivots.
- *SMJ* 2024 (Novelli & Spina): HTE on performance by business-model maturity (firm-level moderator); early-stage startups pivot radically, mature ones optimize. Individual psychological moderators untested.

**Gap:** formal  $T \rightarrow \Delta SI \rightarrow \text{pivot}$  mediation and HTE on pivot using individual psychological traits are both unpublished in this research program.

#### Part IV — Additional results.

*Translation HTE (within treated arm: who converts  $\Delta SI \rightarrow \text{pivot}$ ?)*  $\Delta SI \rightarrow \text{pivot}$  is significant for 92% of moderator runs within the treated arm at P1. One moderator interaction survives: **planning\_future** ×  $\Delta SI \rightarrow \text{pivot}$  (P1:  $\hat{\beta} = +0.049$ ,  $p = 0.015$ ; reverses at P2:  $\hat{\beta} = -0.086$ ,  $p < 0.001$ ). Illusion of control borderline at P2 ( $p = 0.066$ ). All others null. Interpretation: high-planning founders act on learning faster but also “close” on ideas sooner.

*Control arm dynamics.* 60% of control founders have negative  $\Delta SI$  at P1–P2. Predictors of deeper decline: **future\_ev\_influence** ( $\hat{\beta} = -0.37$ ,  $p = 0.041$ ) and **months\_working\_1** ( $\hat{\beta} = -0.009$ ,  $p = 0.086$ ) at P1. Founders who attribute outcomes to unknown external factors deteriorate most without training — consistent with the SDM “causal reasoning” mechanism.

*Attrition HTE.* Training retention benefit (31 pp) is uniform across founder types. Single exception: **exit\_probability** ×  $T$  on dropout-by-P3 ( $\hat{\beta} = +0.113$ ,  $p = 0.012$ ) — founders who were already planning to exit leave regardless of treatment. All other moderators null.

#### Part V — Synthesis and way forward.

Route	What it tests	Status	Evidence
<b>Cognitive HTE</b>	Risk/unc. aversion, learning orient., competitiveness (Diego’s battery)	Pending	17 items, not yet in data
<b>Mechanism</b>	$T \rightarrow \Delta SI \rightarrow \text{pivot}$ mediation	Signal	Partial mediation, P1&P2
<b>Control story</b>	Training prevents deterioration, not only adds	Signal	60% control negative $\Delta SI$
<b>Individual HTE</b>	12 observable moderators	Closed	480+ cells null, 3 estimators
<b>Site HTE</b>	Implementation context	Closed	Replicates Jannace appendix
<b>Theory component</b>	T&E vs EB HTE	Closed (D4)	All null
<b>Attrition</b>	Training retains founders	Uniform	31 pp, not moderated

**The paper needs Diego’s cognitive battery.** With risk aversion, uncertainty aversion, learning orientation, and competitiveness:

- **If signal:** full heterogeneity paper — “founders who tolerate ambiguity / seek learning benefit more from SDM training” — with mediation as supporting mechanism.
- **If null:** mechanism + null paper — the SDM training works uniformly *because* it is designed to teach a domain-general skill (causal reasoning), combined with the prevention-of-deterioration story and the  $T \rightarrow \Delta SI \rightarrow \text{pivot}$  chain. The null heterogeneity is itself a theoretical contribution: SDM is not heterogeneous in its individual-level reach.

Both framings are publishable. The cognitive battery determines which.

**Scripts (R):** 08\_genericml\_d5.R (D5) · 09\_genericml\_d6.R (D6) · 10\_genericml\_d7.R (D7) · 11\_explore\_hits.R (D7 robustness) · 12\_ruta5\_site\_hte.R (site HTE) · 13\_ruta1\_mediation.R · 14\_ruta2\_translation.R · 15\_ruta4\_control\_dynamics.R · 16\_ruta5b\_attrition\_hte.R

**Data:** ERC\_RED\_HMC\_clean.dta ( $N = 6,732$  obs, 8 sites, 3 arms)    **Method:** Chernozhukov et al. (2025, *Econometrica* 93(4))

All results labeled EXPLORATORY.