Understanding the Role of Prognostic Factors (PF) and Effect Modifiers (EM) in Heterogeneity of Treatment Effect using a Within-Subjects Analysis of Variance

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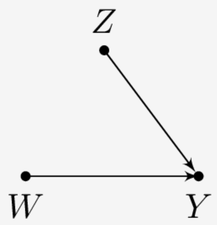
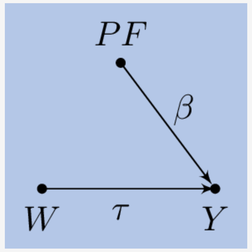
Introduction

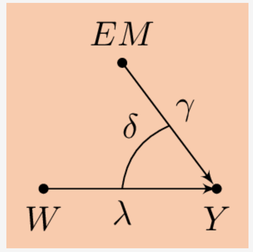
Under the assumption of linear causal relations, a covariate Z can act as a prognostic factor (PF) or as an effect modifier (EM). Two separate causal diagrams are needed.



No structural constraints:
$Y = f(W, Z)$



Linear constraints:
$Y = \tau W + \beta Z$

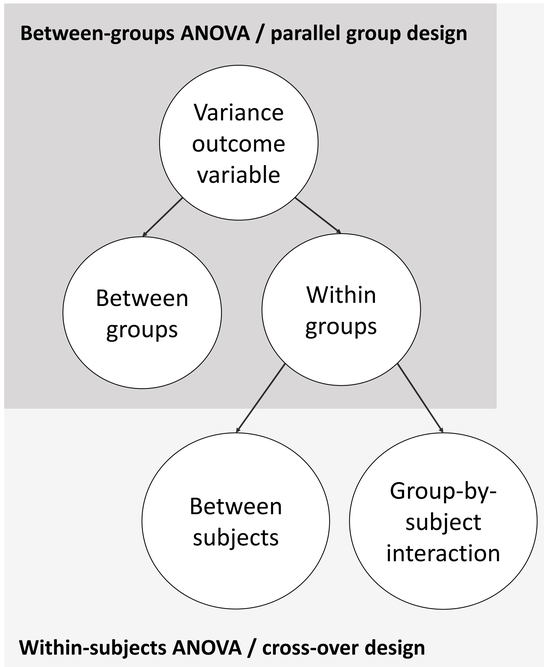


Linear constraints:
$Y = \lambda W + \gamma Z + \delta WZ$

Background

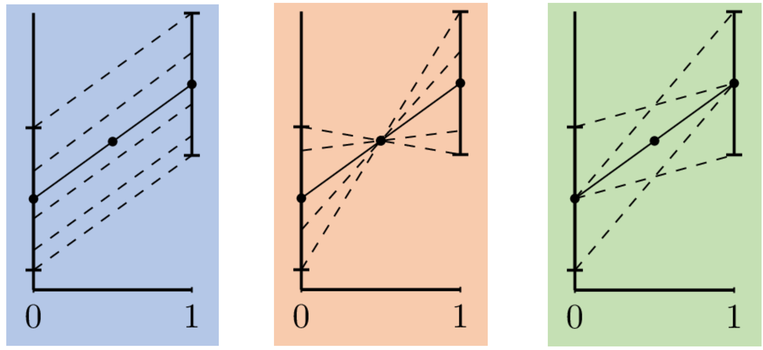
Prognostic factors explain consistent differences between individuals. Effect modifiers explain “non-random variation in the magnitude or direction of a treatment effect” (PATH-statement, 2020, p.35).

Compared with a between-groups ANOVA, in a within-subjects ANOVA the within-groups variance can be further explained by an effect of subject and an interaction-effect.



Synthetic data experiment

Two treatment groups, $n_0 = n_1 = 100$, normally distributed outcome variable with $\mu_0 = 5, \mu_1 = 7.5, \sigma_0 = \sigma_1 = 2$. Three scenarios:



(a) ITE = ATE for all subjects

(b) ITEs cross Grand Mean

(c) Counter-factual is group mean

	Between-groups ANOVA	Within-subjects ANOVA		
Total variance	1046	1046	1046	706
Between groups	219	219	219	219
Within groups	827	827	827	477
Between subjects	-	**814**	11	**238**
Group-by-subject interaction	-	13	**816**	**238**

Conclusion

Prognostic factors explain systematic differences between subjects and can therefore be used to estimate more precise average treatment effects. Heterogeneous treatment effects can be explained by effect modifiers.

P.S. Feedback appreciated.