



Can we mimic the Flynn effect...



... by modeling phenotype environment transmission in the genetic simplex model?

Janneke de Kort & Conor Dolan

- INTRODUCTION - Average intelligence scores increase over generations (i.e. the Flynn effect). Dickens & Flynn explain this phenomenon by combining increasing environmental means over time with phenotypic environmental feedback processes, giving rise to genotype-environment covariance (GE-cov). However within longitudinal twin models, GE-cov is often assumed to be absent. Here we formulate GE-cov as phenotype to environment transmission (i.e. individuals choose environments matching their intelligence). We evaluate whether the extended genetic simplex model (see **basic idea & model specifications**) can mimic the Flynn effect.

Table 1. Ph->E estimates in Full IQ

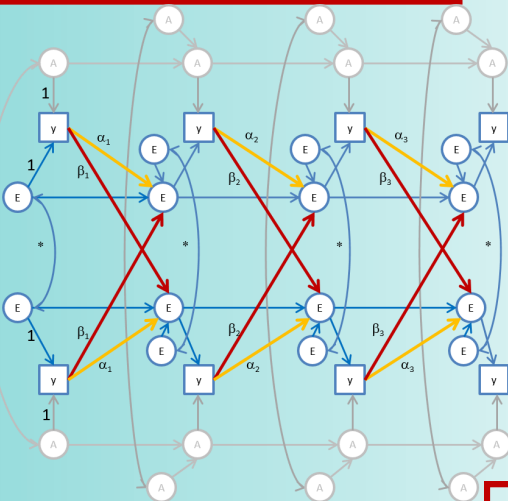
Parameter	FSIQ ML estimate (s.e.)
$\alpha_1 = \alpha_2 = \alpha_3$	0.385 (0.13)
$\beta_1 = \beta_2 = \beta_3$	0.070 (0.03)

Table 2. Influence Ph->E & increase $E(\zeta_{E,t})$ on S.D. units IQ

$\alpha = w_{\alpha\beta} * .385$	$E(\zeta_{E,t}) = w_{\zeta E} * 14.72$	$E(\zeta_{E,t})$	Increase Full IQ in S.D. units
$w_{\alpha\beta} = .25$	$w_{\zeta E} = .25$	3.26	0.25
$w_{\alpha\beta} = .50$	$w_{\zeta E} = .25$	3.26	0.29
$w_{\alpha\beta} = .75$	$w_{\zeta E} = .25$	3.26	0.33
$w_{\alpha\beta} = 1$	$w_{\zeta E} = .25$	3.26	0.39
$w_{\alpha\beta} = .25$	$w_{\zeta E} = .75$	9.78	0.75
$w_{\alpha\beta} = .50$	$w_{\zeta E} = .75$	9.78	0.86
$w_{\alpha\beta} = .75$	$w_{\zeta E} = .75$	9.78	1.00
$w_{\alpha\beta} = 1$	$w_{\zeta E} = .75$	9.78	1.18

- RESULTS - The standard ACE simplex and the AE* model with Ph->E transmission were compatible in their model fit, which shows the utility of the AE* model. During the development of intelligence both types of Ph->E transmission seem present (**Table 1**), which is compatible with Dickens and Flynn's feedback processes. Additionally, when the mean environment is fixed, phenotypic means change as a function of the Ph->E parameters, α and β (**Table 2**). This demonstrates that influences of environmental means are boosted by Ph->E transmission. This pattern supports the important role given to Ph->E transmission (i.e. GE-cov) when explaining the Flynn effect.

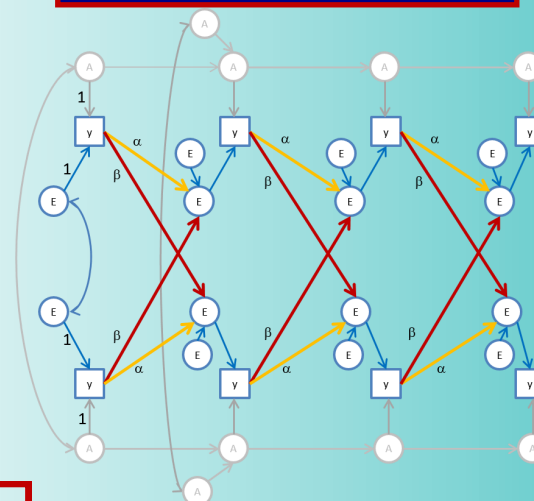
Ph -> E extension



- BASIC IDEA -

Quantify GE-cov as transmission from phenotype to environment (Ph->E) in genetic simplex. Ph->E leads to correlation of genetic influences at time t with environmental influences at time $t+1$, via mediation of the phenotype at time t . Ph->E can occur within twin (α) and between twins (β). Conceptualizations are compatible with niche picking and siblings effect.

Model in full IQ



- METHODS - We analyzed full scale IQ measured at four occasions in 261 MZ and 301 DZ twins pairs (age 5-12) (data made available by the NTR). We compared the fit of the ACE simplex and the AE* simplex including Ph->E transmission. The parameters of the AE* simplex model were used to evaluate the influence of increasing environmental means on the phenotypic means. We varied weights given to Ph->E transmission parameters found (α & β) and weights given to environmental means $E(\zeta_{E,t})$ and $E(\zeta_{E,t+1})$ and evaluated the increase in phenotypic means.

- MODEL SPECIFICATION -

Observed: $y_{it} = b_{0t} + A_{it} + E^*_{it} + z_{it}$
Time specific error: $z_{it} = a_{it} + c_{it} + e_{it}$
Additive Genetic: $A_{it} = \beta_{A,t,t-1} A_{it-1} + \zeta_{Ait}$
Environment: $E^*_{it} = \beta_{E,t,t-1} E^*_{it-1} + \zeta_{E^*it}$

- GE COV EXTENSION -

$$E^*_{1t} = \beta_{E,t,t-1} E^*_{1t-1} + \alpha_t y_{1t-1} + \beta_t y^*_{2t-1} + \zeta_{E^*1t}$$

$$E^*_{2t} = \beta_{E,t,t-1} E^*_{2t-1} + \alpha_t y_{2t-1} + \beta_t y^*_{1t-1} + \zeta_{E^*2t}$$

- ENVIRONMENTAL MEANS -

$$m(E^*_{1t}) = b_{E,t,t-1} m(E^*_{1t-1}) + \alpha_t m(y^*_{1t-1}) + \beta_t m(y^*_{2t-1}) + m(\zeta_{E^*1t})$$

$$m(E^*_{2t}) = b_{E,t,t-1} m(E^*_{2t-1}) + \alpha_t m(y^*_{2t-1}) + \beta_t m(y^*_{1t-1}) + m(\zeta_{E^*2t})$$

- DISCUSSION - The extended AE* simplex seems adequate to model phenotypic transmission in longitudinal data. We observed that Ph->E transmission can amplify the influence of increasing environmental means on the average score of intelligence. As such the extended AE* model helps to explain the Flynn-effect. As our observations are in line with Dickens and Flynn explanation of the Flynn effect, the extended AE* model might be considered as a tool to test Dickens and Flynn's model of the Flynn effect in empirical data.

Based on:

C.V. Dolan, J.M. de Kort, K.-J. Kan, Toos C.E.M. van Beijsterveldt, M. Bartels, & D.I. Boomsma. (2014). Can GE-covariance originating in phenotype to environment transmission account for the Flynn effect? *Intelligence* (in review).

Contacts:

Janneke M. De Kort: j.m.de.kort@vu.nl
Conor V. Dolan: c.v.dolan@vu.nl
Department of Biological Psychology, VU University,
van der Boerhorststraat 1, 1081 BT, Amsterdam, the Netherlands

