Supplemental Materials

Computation of learning effects using the "once vs. twice tested" method

In this study, we wanted to estimate the effect of development, but our participants performed the same task four times in four years. Therefore, we had to account for the effect of learning across visits. Here is a description of the algorithm as applied:

The cross-sectional fit of variable y (here, executive control) vs age is computed across all participants for each visit separately producing: ***fit1*** *(based on only 1st visits)*, ***fit2*** *(based on only 2nd visits)*, ***fit3*** *(based on only 3rd visits)*, ***fit4*** *(based on only 4th visits).* Specifically, for dependent measure y, we used the following GAM models:

fit1: $y_{i1} = b_1 + s_{M1}(age_{i1})I(sex_i == M) + s_{F1}(age_{i1})I(sex_i == F) + a_1*sex_i + e_{i1}$
fit2: $y_{i2} = b_2 + s_{M2}(age_{i2})I(sex_i == M) + s_{F2}(age_{i2})I(sex_i == F) + a_2*sex_i + e_{i2}$
fit3: $y_{i3} = b_3 + s_{M3}(age_{i3})I(sex_i == M) + s_{F3}(age_{i3})I(sex_i == F) + a_3*sex_i + e_{i3}$
fit4: $y_{i4} = b_4 + s_{M4}(age_{i4})I(sex_i == M) + s_{F4}(age_{i4})I(sex_i == F) + a_4*sex_i + e_{i4}$

where y_{ij} is the response and age_{ij} is the age of the ith subject at the jth visit, sex_i is the ith subject's sex, s_{Mj} and s_{Fj} are smooth age-based curves for visit j specific to males and females, respectively, and I() is an indicator function which equals 1 if the logical statement inside the parantheses is true, and 0 otherwise.

There has been no learning yet at visit 1, therefore the values (executive control) of visit 1 do not need to be adjusted for experience effects.

The estimated age-dependent learning at visit 2 is the difference between the predicted values of cross-sectional ***fit2*** applied to subject visit 2 ages minus the predicted values of cross-sectional ***fit1*** applied to the same visit 2 ages:

$$practice_{i2} = (b_2 + s_M(age_{i2})I(sex_i == M) + s_F(age_{i2})I(sex_i == F) + a_2*sex_i) - (b_1 + s_M(age_{i2})I(sex_i == M) + s_F(age_{i2})I(sex_i == F) + a_1*sex_i)$$

This is essentially the usual "once versus twice tested" approach.

The estimate of practice effects at visit 3 is the difference between the predicted values of cross-sectional ***fit3*** applied to subject ages at visit 3 minus the predicted values of cross-sectional ***fit2*** again applied to subject ages at visit 3:

$$practice_{i3} = (b_3 + s_M(age_{i3})I(sex_i == M) + s_F(age_{i3})I(sex_i == F) + a_3*sex_i) - (b_2 + s_M(age_{i3})I(sex_i == M) + s_F(age_{i3})I(sex_i == F) + a_2*sex_i)$$

The estimated practice effect for visit 4 is

$$practice_{i4} = (b_4 + s_M(age_{i4})I(sex_i == M) + s_F(age_{i4})I(sex_i == F) + a_4*sex_i) -$$

$$(b_3 + s_M(age_{i4})I(sex_i == M) + s_F(age_{i4})I(sex_i == F) + a_3{*}sex_i)$$

Finally, these age- and sex-dependent practice effects are subtracted from the dependent measure y to get y.adj:

$$y.adj_{ij} = y + practice_{i2} + \dots + practice_{ij}$$

for j = 2, 3, and 4.

Model to evaluate the developmental effect

The model to estimate developmental effects implements a Generalized Additive Mixed Model (GAMM) on y.adj:

$$y.adj_{ij} = b + s_M(age_{ij})I(sex_i == M) + s_F(age_{ij})I(sex_i == F) + a{*}sex_i + c_i + e_{ij}$$

where terms are as before, but with the model applied to all visits simultaneously and with a subject-level random intercept c_i.

Model to evaluate the alcohol effect

The impact of alcohol on development is tested in a series of nested regressions on the full (longitudinal) data:

model 1: $y.adj_{ij} = b + c{*}cahalan_i + e_{ij}$
model 2: $y.adj_{ij} = b + c{*}cahalan_i + d{*}visit_j + e_{ij}$
model 3: $y.adj_{ij} = b + c{*}cahalan_i + d{*}visit_j + s(age_{ij}) + e_{ij}$
model 4: $y.adj_{ij} = b + c{*}cahalan_i + d{*}visit_j + s(age_{ij}) + e_{ij}$