Modeling the determinants of age-related changes in fluid intelligence (#1139)

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1) What's the main question being asked or hypothesis being tested in this study?
What is the nature of age-related decline in fluid intelligence in old age?

2) Describe the key dependent variable(s) specifying how they will be measured.
-Behaviourally, we use the raw scores (correct/incorrect) on 13 fluid intelligence items, measured in three waves years apart (maximum interval: 9 years).
-Neurally, we use the tract-based mean summary measures (including FA) in multiple white matter tracts, as well as volumetric measures of 10 grey matter regions
For more information, see http://biobank.ctsu.ox.ac.uk/showcase/label.cgi?id=100026

3) How many and which conditions will participants be assigned to?
N/A

4) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
Our goal is to a) examine the nature of age-related decline in fluid intelligence and b) model the neural and lifespan determinants of this decline. The analyses will consist of three explanatory steps, as follows:
1) First, we will model longitudinal change in fluid intelligence. We will do so using a Latent Growth Curve Model, using Full Information Maximum Likelihood with Satorra-Bentler scaled test statistics. Key questions include:
a. What is the magnitude of decline, as captured by the slope?
b. Is there significant variance associated with this slope (i.e. do people differ in their rate of decline)?
c. Is the slope linear or non-linear (does a second quadratic latent growth factor capture meaningful variance above the linear decline)?
d. Does the rate of decline (slope) depend on the level (intercept)?
e. If feasible in terms of model convergence: Is there evidence for subgroups (growth mixture models)?
2) Second, we will use brain structural measures (grey matter across a number of brain regions available for 5,724 people; white matter for 4,941 people) and a MIMIC model to predict individual differences in fluid intelligence change, focusing on the following key questions:
a. What neural regions determine the intercept and slope of fluid intelligence?
b. Are the neural determinants of the intercept (general ability) the same as those of the slope (rate of decline)?
c. Do multiple region specific markers of neural health predict unique variance in cognitive level and slope, or does a single global marker suffice?
We hypothesize that: a) the intercept will show stronger neural effects, most strongly so for frontal white matter; b) the intercept and slope will have similar but non-identical multiple brain determinants; c) white and grey matter will provide partly complementary predictions (based partly on our prior cross-sectional work; Kievit et al., 2014).
3) Third, in a more exploratory set of analyses, we will identify subgroups of individuals based on the nature of their fluid intelligence trajectory. If there is evidence for qualitative heterogeneity based on latent growth mixture models, we will use a set of exogenous covariates to predict and understand memberships of these groups, focusing specifically on subgroups that could be described as aging resiliently (little or no decline) or ages at risk (particularly swift decline). Group membership predictors include:
a. Neural health (white/grey matter)
b. Physical health
c. Mental health
d. Lifestyle (Drinking/smoking)
e. Socioeconomic factors (childhood deprivation index & current SES)

5) Any secondary analyses?
See above

6) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
The behavioural sample comprises 165,491 people measured at wave 1, 20,042 at wave 2 and 9,167 wave 3; ages at baseline range from 45 to 82. This gives sufficient power to detect any non-trivial effect and enable sensitive model comparison (previous power analyses of LGM's rarely even include sample sizes of this magnitude). This analysis is based on existing Biobank data, so our sampling plan is 'all the data available'. Given the magnitude of the sample we will focus on model based comparisons and parameter estimation over significance testing.
Note that although the data have already been collected, our preregistration is 'true' preregistration in that we have not yet received the data on the day of submission of our preregistration protocol. Our full proposal is currently being processed (documentation for the data acquisition timeline available upon request).

7) Anything else you would like to pre-register? (e.g., data exclusions, variables collected for exploratory purposes, unusual analyses planned?)

-The neural data in Biobank are currently only cross-sectional. If longitudinal brain data (wave 2) becomes available prior to completion of this project (unlikely), we would like to include not just the 'intercept' of the neural markers but also their rate of decline (slopes), to predict changes in fluid intelligence. If this happens, we will submit a second proposal detailing these analyses.

8) Have any data been collected for this study already?

No, no data have been collected for this study yet