

## **Description of Additional Supplementary Files**

**Supplementary Data 1:** Variable description and SNP heritability of phenotypes in the Simons Foundation Powering Autism Research for Knowledge (SPARK) sample

**Supplementary Data 2:** Identification of phenotype subsets in SPARK

**Supplementary Data 3:** Model fit comparison in exploratory models in SPARK

**Supplementary Data 4:** Model fit comparison

**Supplementary Data 5:** Best-fitting structural model in SPARK

**Supplementary Data 6:** Variable description and SNP heritability of phenotypes in the Simons Simplex Collection (SSC) sample

**Supplementary Data 7:** Best-fitting structural model in SSC

**Supplementary Data 8:** Comparison of genetic EFA factor loadings

**Supplementary Data 9:** Comparison of genetic factor loadings across EFA and GRM-SEM

**Supplementary Data 10:** GRM-SEM simulations for a six-variate trait with two genetic factors without cross-loadings (2,000 individuals per phenotype, 5,000 causal loci): Factor loadings

**Supplementary Data 11:** GRM-SEM simulations for a six-variate trait with two genetic factors without cross-loadings (2,000 individuals per phenotype, 5,000 causal loci): Genetic and residual variance

**Supplementary Data 12:** GRM-SEM simulations for a six-variate trait with two common genetic factors with cross-loading (2,000 individuals per phenotype, 5,000 causal loci): Factor loadings

**Supplementary Data 13:** GRM-SEM simulations for a six-variate trait with two genetic factors with cross-loading (2,000 individuals per phenotype, 5,000 causal loci): Genetic and residual variance