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Corrigendum

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Corrigendum: Mutualistic Coupling Between Vocabulary and Reasoning Supports Cognitive Development During Late Adolescence and Early Adulthood

Original article: Kievit, R. A., Lindenberger, U., Goodyer, I. M., Jones, P. B., Fonagy, P., Bullmore, E. T., the Neuroscience in Psychiatry Network, & Dolan, R. J. (2017). Mutualistic coupling between vocabulary and reasoning supports cognitive development during late adolescence and early adulthood. *Psychological Science, 28*, 1419–1431. doi:10.1177/0956797617710785

This article contains analyses of data from the Neuroscience in Psychiatry Network cohort. The first author recently learned of a number of minor errors in the raw Wechsler Abbreviated Scale of Intelligence scores analyzed in the article (e.g., due to occasional failures to follow stopping rules and miscalculations). According to the cohort management team, those errors have been corrected. Kievit reran all of the reported analyses using the correct values. Most values changed only very slightly, and the corrected values do not materially affect any of the results of the core analyses, including key model comparisons, parameters, or inferences. This Corrigendum lists all the values being corrected and indicates where those values occur in the article. Note that none of the wording in the passages reproduced here is being changed from the original; only selected statistical values within these passages are being updated.

In the third sentence of the abstract (p. 1419), the *N* is being changed to 784, and the *n* is being changed to 563. Next, the Sample section (p. 1421) is being changed as follows:

> We recruited 784 participants (401 female, 383 male; mean age: 19.05 years, range: 14.10–24.99) for the University of Cambridge-University College London Neuroscience in Psychiatry Network (NSPN) cohort. This sample size has been shown to be sufficient to fit moderately complex structural equation models with adequate power (e.g., Wolf, Harrington, Clark, & Miller, 2013). We tested 563 of these participants a second time, on average 1.48 years later (range: 0.98–2.62 years). Those who returned for a second wave did not differ significantly from those who did not return on Time 1 Vocabulary scores, $t(369.24) = 0.44$, $BF_{01} = 10.21$,[1] as well as on Time 1 Matrix Reasoning scores, $t(368.09) = 0.51$, $BF_{01} = 9.85$; sex, $\chi^2(1, N = 784) = 0.50$, $BF_{01} = 9.14$, and current or past treatments for emotional, behavioral, or mental health problems—current: $t(275.73) = -1.46$, $BF_{01} = 2.19$, past: $t(344.07) = -1.19$, $BF_{01} = 2.19$. These groups also did not significantly differ in terms of parental education—i.e., the age at which their mothers left school, $t(157.09) = -0.87$, $BF_{01} = 4.89$, or fathers left school, $t(159.4) = -0.49$, $BF_{01} = 6.28$. Participants with complete data were slightly younger at the time of first testing ($M = 18.80$ years) than those with incomplete data ($M = 19.68$ years), $t(420.18) = -3.83$, $BF_{01} = 83.52$ and had slightly higher scores on the Barratt Impulsiveness Scale (BIS, Version 11; Stanford et al., 2009; *M*s = 63.39 vs. 60.48, respectively), $t(395.25) = -3.77$, $BF_{01} = 92.04$. Implementing either complete case analysis or excluding individuals with BIS scores above a cutoff of 74 (see Stanford et al., 2009, p. 387) did not meaningfully affect the model parameters or model comparisons reported here. The role of age is discussed in more detail in the Results. Prior to the study, full ethical approval was obtained from the University of Cambridge Central Ethics Committee (Reference No. 12/EE/0250).

The first paragraph of Results (p. 1423) is being changed as follows:

> Raw scores and descriptive statistics for the Matrix Reasoning and Vocabulary subtests are shown in Table 1, and the association between age and

Table 1. Raw Scores and Descriptive Statistics for Matrix Reasoning and Vocabulary Scores

Task	*N*	Score				Skewness	Excess kurtosis
		Mean	Minimum	Maximum	*SD*		
Matrix Reasoning Time 1	784	28.99	14	35	3.21	–0.88	1.47
Matrix Reasoning Time 2	563	29.61	17	35	2.89	–0.82	0.77
Vocabulary Time 1	784	58.44	27	78	7.81	–0.24	0.06
Vocabulary Time 2	563	59.06	23	77	7.51	–0.40	0.40

score on each test is shown in Figure 2. Before fitting the models shown in Figure 1, we fitted two univariate LCS models to Vocabulary and Matrix Reasoning scores in order to quantify change within each domain. Both models fitted the data well: Matrix Reasoning: $\chi^2(1) = 3.098$, $p = .078$; RMSEA = .052, 90% confidence interval (CI) = [0.000, 0.119]; CFI = 0.995; SRMR = 0.014; Yuan-Bentler scaling factor = 0.904; Vocabulary: $\chi^2(1) = 0.197$, $p = .657$; RMSEA = 0.00, 90% CI = [0.000, 0.070]; CFI = 1.0; SRMR = 0.003; Yuan-Bentler scaling factor = 1.057. Both models showed evidence for change over time (unstandardized change-score intercepts[2]—Matrix Reasoning: 10.252, $SE = 0.747$, $z = 13.723$; Vocabulary: 8.367, $SE = 1.146$, $z = 7.301$). Further, both models showed evidence for negative feedback: Higher scores at Time 1 were associated with less improvement at Time 2, a pattern compatible with regression to the mean and developmental-ceiling effects (Matrix Reasoning: −0.333, $SE = 0.025$, $z = -13.29$; Vocabulary: −0.134, $SE = 0.19$, $z = -7.05$). Finally, both models revealed significant evidence for individual differences in change scores (variance of Matrix Reasoning change scores = 2.89, $SE = 0.23$, $z = 12.70$; variance of Vocabulary change scores = 10.23, $SE = 0.70$, $z = 14.54$).

In addition, the fourth sentence of the second paragraph of Results (p. 1423) is being changed. as follows: "Imposing strong invariance (equality of both factor loadings and thresholds) also led to acceptable decrease in model fit (ΔCFI = 0.011)." The last two sentences of the third paragraph of Results (p. 1424) are also being changed:

> Compared with the other two models, the mutualism model was 2.45×10^7 times more likely to be the best model. As the investment model was nested within the mutualism model, we compared the two with a chi-square test, which again showed that the mutualism model outperformed the investment model, $\Delta\chi^2(1) = 22.829$, $p < .001$.

In the fourth paragraph of Results (p.1425), the third sentence is being changed as follows:

> In addition to significant latent change intercepts (i.e., increasing scores), variance of change scores led to a substantial drop in model fit when fixed to 0—Matrix Reasoning: $\Delta\chi^2(1) = 82.43$, $p < .001$; Vocabulary: $\Delta\chi^2(1) = 11.352$, $p < .001$, which suggests that there were considerable individual differences in change between Time 1 and Time 2.

Also in the fourth paragraph of Results, the fifth and sixth sentences are being changed:

> The coupling effect from Time 1 Vocabulary scores on gains in Matrix Reasoning scores was of typical size ($r = .203$, $r^2 = 4.1\%$) for individual differences analyses, and the fully standardized estimate of Matrix Reasoning on Vocabulary gains was in the small to typical range ($r = .155$, $r^2 = 2.4\%$; Gignac & Szodorai, 2016). Together, the self-feedback and coupling parameters accounted for 31.3% of the individual differences in Matrix Reasoning score changes and for 11.3% of the individual differences in Vocabulary score changes, which illustrates the considerable importance of longitudinal kinematics in cognitive development.

The final sentence of the fourth paragraph is also being changed: "Further control analyses suggested that the mutualism model could be equality constrained across sexes without a notable drop in model fit, $\Delta\chi^2(18) = 18.32$, $p = .44$."

In the seventh paragraph of Results (p. 1426), the third sentence is being changed as follows: "Allowing age to directly predict change scores did not improve model fit, $\Delta\chi^2(2) = 0.33$, $p = .85$, in line with this hypothesis." The seventh sentence in that paragraph is also being changed: "An ages-squared term as predictor of scores at Time 1 could be fixed to 0 without a decrease in model fit, $\Delta\chi^2(2) = 6.50$, $p = .039$, which suggests that a linear term would suffice." (The original chi-square

Table 2. Fit Statistics for Each of the Three Models

Model	χ^2	*df*	RMSEA	CFI	SRMR
g factor	28.990	3	0.105 [0.076, 0.138]	0.982	0.031
Investment	26.477	3	0.100 [0.068, 0.136]	0.984	0.040
Mutual	0.328	2	0.000 [0.000, 0.040]	1.00	0.002

test given in the previous sentence was nonsignificant, whereas the updated result given here is nominally significant. Closer inspection shows that the quadratic parameter estimate itself is not significant, and the Bayesian information criterion favors the simpler model, together suggesting that the conclusion of negligible benefit of the quadratic term remains supported.) The final sentence of the seventh paragraph of Results is also being changed: "The mutualism model was preferred to all three conceptualizations of the *g* model—ΔBIC = 29.36 (original *g*-factor model), ΔBIC = 51.85 (alternative A); ΔBIC = 7.27 (alternative B)."

Finally, at the beginning of the Discussion (p. 1427), the *N* is being corrected to 784. The majority of the values in Table 1 (p. 1423), Table 2 (p. 1425), Figure 2 (p. 1424), Figure 3a (p. 1425), Figure 4 (p. 1426), and Figure 5 (p. 1427) are also being changed as shown here (the table notes and figure captions are remaining the same). In addition, Table S1 in the Supplemental Material is being updated.

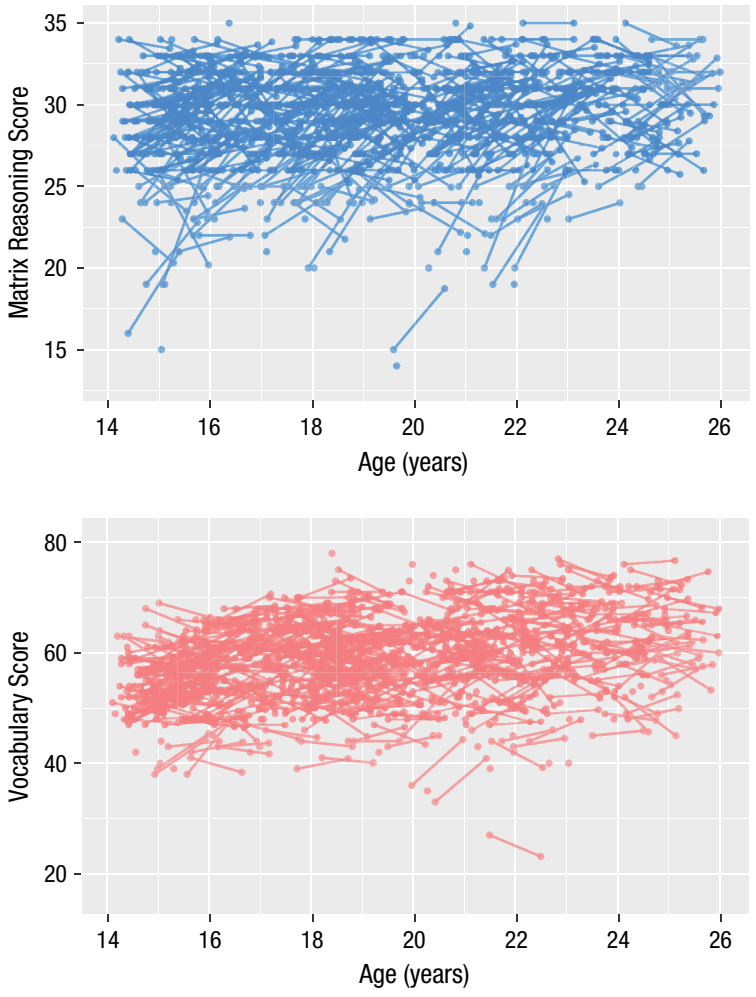

Fig. 2.

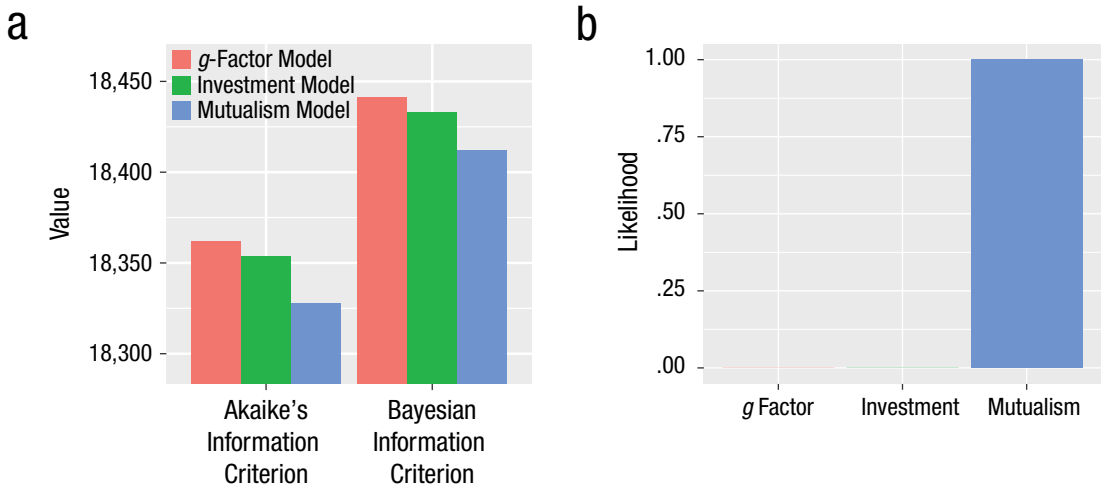
a
g-Factor Model
Investment Model
Mutualism Model
18,450
18,400
18,350
18,300
Value
Akaike's Information Criterion
Bayesian Information Criterion
b
1.00
.75
.50
.25
.00
Likelihood
g Factor
Investment
Mutualism

Fig. 3.

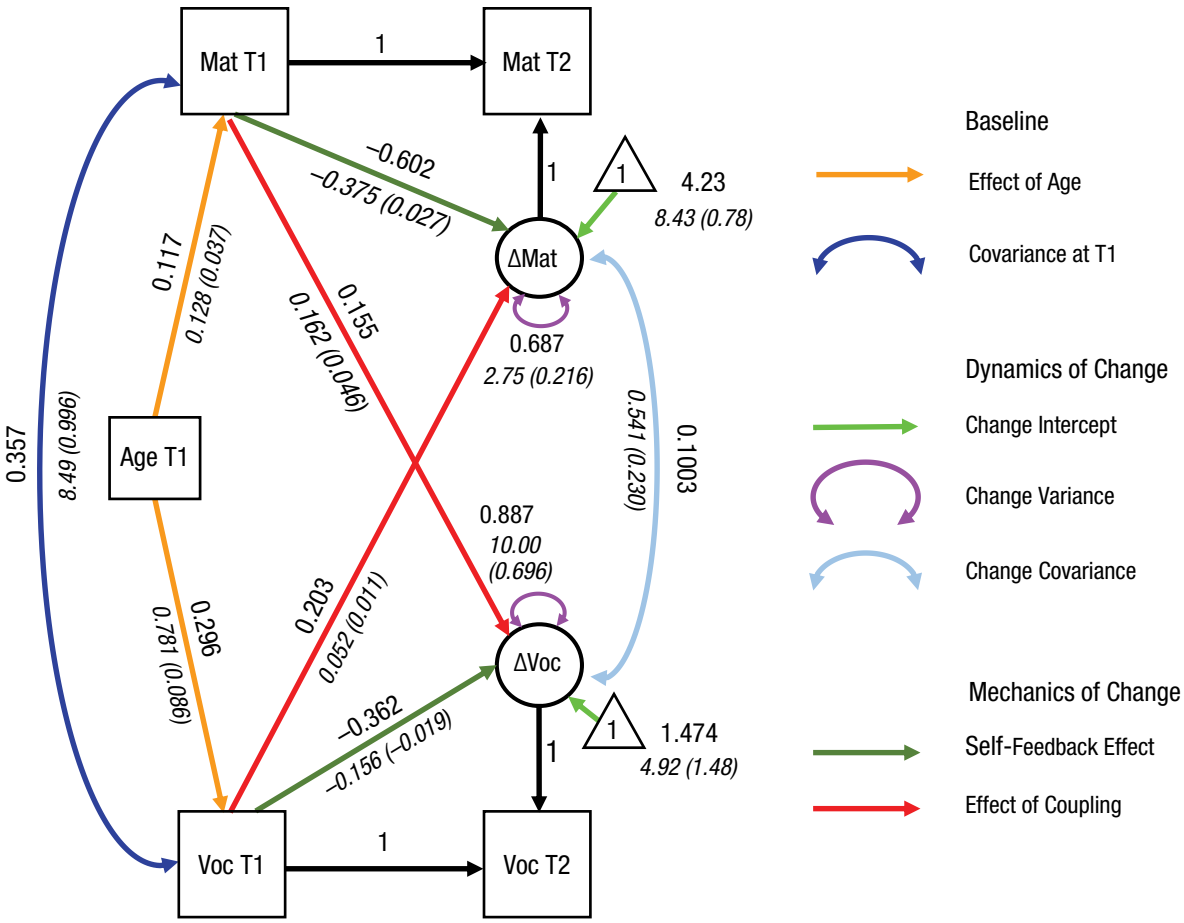
Mat T1
Mat T2
Voc T1
Voc T2
Age T1
ΔMat
ΔVoc
1
−0.602
−0.375 (0.027)
4.23
8.43 (0.78)
0.687
2.75 (0.216)
0.117
0.128 (0.037)
0.155
0.162 (0.046)
0.357
8.49 (0.996)
0.541 (0.230)
0.1003
0.887
10.00
(0.696)
0.203
0.052 (0.011)
0.296
0.781 (0.086)
−0.362
−0.156 (−0.019)
1.474
4.92 (1.48)
Baseline
Effect of Age
Covariance at T1
Dynamics of Change
Change Intercept
Change Variance
Change Covariance
Mechanics of Change
Self-Feedback Effect
Effect of Coupling

Fig. 4.

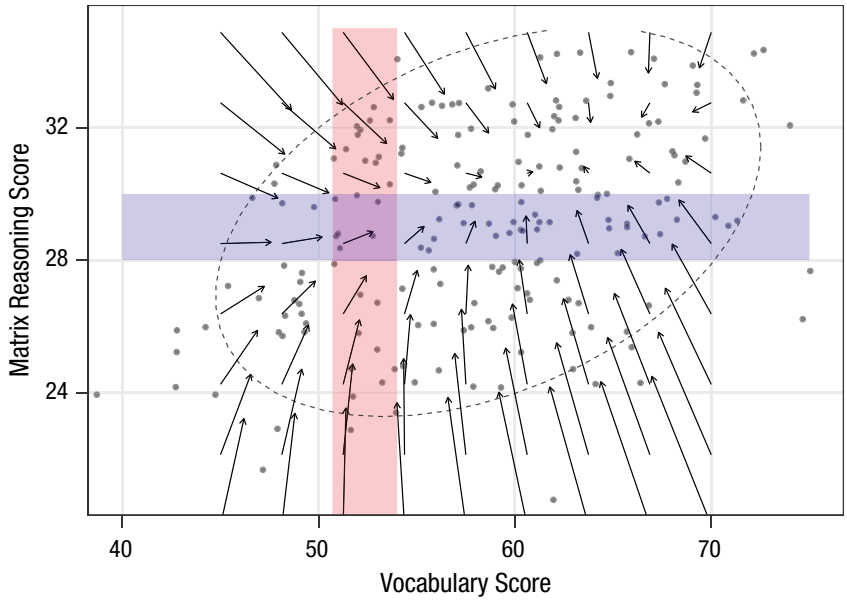

Fig. 5.