

University of Groningen

## Flexible regression-based norming of psychological tests

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DOI:  
[10.33612/diss.124765653](https://doi.org/10.33612/diss.124765653)

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*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2020

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*  
Voncken, L. (2020). *Flexible regression-based norming of psychological tests*. University of Groningen. <https://doi.org/10.33612/diss.124765653>

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## Additional material for Chapter 4

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### Population model parameters

The population model parameters for distributional parameters  $\mu$  (location),  $\sigma$  (scale),  $\nu$  (skewness), and  $\tau$  (kurtosis) are as follows

#### SON-R 6-40 model

$$\begin{aligned}\mu_{\text{SON}} &= \beta_{\mu 0} + \beta_{\mu 1} \cdot f_1(\text{age}) + \beta_{\mu 2} \cdot f_2(\text{age}) + \beta_{\mu 3} \cdot f_3(\text{age}) + \beta_{\mu 4} \cdot f_4(\text{age}) \\ &= 13.12 + 102.80 \cdot f_1(\text{age}) - 66.38 \cdot f_2(\text{age}) + 27.19 \cdot f_3(\text{age}) - 7.94 \cdot f_4(\text{age}),\end{aligned}$$

$$\sigma_{\text{SON}} = \beta_{\sigma 0} + \beta_{\sigma 1} \cdot f_1(\text{age}) + \beta_{\sigma 2} \cdot f_2(\text{age}) = -1.79 - 8.92 \cdot f_1(\text{age}) - 3.74 \cdot f_2(\text{age}),$$

$$\nu_{\text{SON}} = \beta_{\nu 0} + \beta_{\nu 1} \cdot f_1(\text{age}) = 2.44 + 44.61 \cdot f_1(\text{age}),$$

$$\tau_{\text{SON}} = \beta_{\tau 0} + \beta_{\tau 1} \cdot f_1(\text{age}) = 0.84 + 19.64 \cdot f_1(\text{age}),$$

#### FEEST model

$$\begin{aligned}\mu_{\text{FEEST}} &= \beta_{\mu 0} + \beta_{\mu 1} \cdot f_1(\text{age}) + \beta_{\mu 2} \cdot f_2(\text{age}) + \beta_{\mu 3} \cdot \text{sex}_{\text{female}} + \beta_{\mu 4} \cdot \text{education}_6 \\ &= 42.53 - 23.02 \cdot f_1(\text{age}) - 18.80 \cdot f_2(\text{age}) + 0.90 \cdot \text{sex}_{\text{female}} + 4.92 \cdot \text{education}_6,\end{aligned}$$

$$\sigma_{\text{FEEST}} = \beta_{\sigma 0} = -1.59,$$

$$\nu_{\text{FEEST}} = \beta_{\nu 0} + \beta_{\nu 1} \cdot \text{age} + \beta_{\nu 2} \cdot \text{education}_6 = 9.04 - 0.08 \cdot \text{age} + 5.50 \cdot \text{education}_6,$$

$$\tau_{\text{FEEST}} = \beta_{\tau 0} = 0.20,$$

where  $f_d(\text{age})$  refers to an orthogonal polynomial of age, with degree  $d$ . The predictors sex and education level are fixed to females and education category 6, respectively.

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## Additional material for Chapter 5

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### Population model parameters

The population models  $M_{\text{prior}}$  and  $M_{\text{norm}}$ , with distributional parameters  $\mu$  (mean) and  $\sigma$  (standard deviation), are specified in Table B1.

Table B1

*Distributional parameters of the population models in the simulation study*

Population model	Distributional parameter		
	$\mu$	$\sigma$	
$M_{\text{prior}}$	$g(\text{age})$	$h(\text{age})$	
$M_{\text{norm}}$	zero	$g(\text{age})$	$h(\text{age})$
	$\mu$	$g(\text{age}) + 5$	$h(\text{age})$
	$\sigma$	$g(\text{age})$	$h(\text{age}) + 3$
	$\mu$ & $\sigma$	$g(\text{age}) + 5$	$h(\text{age}) + 3$
	$\mu_{\text{age}}$	$1.1 g(\text{age}) - 10$	$h(\text{age})$

*Note.*  $g(\text{age}) = \beta_{\mu 0} + \beta_{\mu 1} \cdot f(\text{age})$ , and  $h(\text{age}) = \beta_{\sigma 0} + \beta_{\sigma 1} \cdot f(\text{age})$ .

Table B2

Mean RMSEs (and SDs) of the models across prior type, prior misspecification,  $N_{prior}$ , and  $N_{norm}$ , across 1,000 replications.

Prior misspecification			zero			$\mu$			$\sigma$			$\mu$ & $\sigma$			$\mu_{age}$		
$N_{orig}$	$N_{norm}$	Prior	PM	FE	WI	PM	FE	WI	PM	FE	WI	PM	FE	NI	PM	FE	WI
500	250		3.206	2.243	3.071	3.150	2.240	3.053	2.543	2.050	2.952	2.506	2.025	2.839	5.000	3.530	3.089
			(1.094)	(0.624)	(0.808)	(0.734)	(0.666)	(0.865)	(0.639)	(0.635)	(0.840)	(0.619)	(0.610)	(0.824)	(1.188)	(0.726)	(0.816)
	500		2.654	1.838	2.243	2.669	1.842	2.241	2.234	1.665	2.149	2.213	1.653	2.158	3.972	2.740	2.262
			(0.582)	(0.465)	(0.596)	(0.599)	(0.474)	(0.587)	(1.224)	(0.477)	(0.585)	(1.204)	(0.441)	(0.583)	(0.712)	(0.605)	(0.573)
	1,000		2.162	1.508	1.684	2.174	1.514	1.683	1.840	1.334	1.594	1.881	1.349	1.618	3.035	2.051	1.706
			(0.444)	(0.365)	(0.414)	(0.461)	(0.342)	(0.390)	(0.766)	(0.329)	(0.399)	(1.000)	(0.328)	(0.405)	(1.017)	(0.450)	(0.412)
1,000	250		2.764	2.038	3.072	2.655	2.008	3.056	2.155	1.892	2.953	2.275	1.904	2.990	4.789	3.797	3.080
			(1.821)	(0.621)	(0.811)	(1.036)	(0.600)	(0.784)	(0.622)	(0.607)	(0.833)	(1.472)	(0.648)	(0.847)	(1.098)	(0.639)	(0.818)
	500		2.264	1.660	2.285	2.249	1.641	2.280	1.908	1.530	2.159	1.856	1.562	2.202	4.104	3.179	2.273
			(0.497)	(0.437)	(0.588)	(0.977)	(0.441)	(0.603)	(1.387)	(0.419)	(0.571)	(0.449)	(0.452)	(0.578)	(0.614)	(0.538)	(0.591)
	1,000		1.919	1.383	1.680	1.945	1.383	1.679	1.612	1.257	1.604	1.598	1.242	1.591	3.273	2.444	1.699
			(0.409)	(0.330)	(0.415)	(0.952)	(0.337)	(0.406)	(0.995)	(0.317)	(0.420)	(1.003)	(0.285)	(0.385)	(1.006)	(0.448)	(0.420)
2,000	250		2.215	1.778	3.058	2.220	1.826	3.048	1.978	1.814	2.950	1.963	1.768	2.895	4.612	4.014	3.079
			(1.065)	(0.633)	(0.828)	(0.615)	(0.656)	(0.800)	(0.946)	(0.648)	(0.845)	(1.124)	(0.603)	(0.782)	(0.569)	(0.501)	(0.814)
	500		1.862	1.451	2.237	1.887	1.471	2.251	1.590	1.457	2.151	1.602	1.463	2.163	4.191	3.557	2.281
			(0.424)	(0.409)	(0.560)	(0.451)	(0.433)	(0.579)	(0.431)	(0.424)	(0.558)	(0.437)	(0.423)	(0.594)	(0.996)	(0.444)	(0.584)
	1,000		1.650	1.218	1.650	1.719	1.224	1.675	1.409	1.169	1.582	1.384	1.195	1.609	3.594	2.965	1.690
			(0.943)	(0.295)	(0.398)	(1.552)	(0.310)	(0.397)	(1.208)	(0.283)	(0.390)	(0.742)	(0.313)	(0.416)	(1.302)	(0.391)	(0.401)

Note. SDs between parentheses. All RMSEs are multiplied by 100. PM, FE, and WI represent the posterior mode, fixed effects, and weakly informative prior, respectively.  $\mu$ ,  $\sigma$ ,  $\mu$  &  $\sigma$ , and  $\mu_{age}$  represent an age (in)dependent prior misspecification in  $\mu$ ,  $\sigma$ , or both.