Skewed Distributions, Unipolar Traits, Excess Zeros, and IRT Modeling of Health Constructs

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Assumptions of IRT

IRT models are valuable psychometric tools when the model-derived latent variable scale (θ) accurately reflects individual differences on the trait the researcher is trying to measure and the estimated item parameters faithfully reflect the relation between trait levels and the probability of category response. This assumes:

Assumptions of IRT

1) The latent trait exists and is causative (not emergent)

2) Item response data are locally independent/monotonic

Assumptions of IRT

3) The calibration sample is homogeneous/representative.

4) The parametric form of the model is correct and errors are logistic (in logistic models) or normal (in normal-ogive models).

5) The item response data are unidimensional (one common source) and item parameters reflect that common source.

Assumptions of IRT

6) The latent trait is continuous, bipolar, and the shape of the latent variable is properly specified during estimation. In other words, it is assumed that the latent trait is a continuous "bipolar trait" that has substantively meaningful variation across the range of the latent variable (Lucke. 2015, p. 273).

Assumptions of IRT

The validity of the conclusions drawn from any IRT model application is threatened to the degree that any of these assumptions are violated.

Misspecifications Caused by Non-Normality:

Woods and Thissen (2006, p. 283) nicely summarize the consequences of non-normality:

"There is fairly consistent evidence that, when normality of $g(\theta)$ is assumed, MML estimates of more extreme item parameters (e.g., thresholds around ±2) are nontrivially biased when the true population distribution is platykurtic or skewed, and if $g(\theta)$ is skewed, the bias increases as the skewness increases."

Possible Causes of Non-Normality:

- Latent trait is continuous but non-normal
- Latent trait is unipolar
- Excess zeros in the data
- Heterogeneous Errors

* These are not mutually exclusive

Non-Normally Distributed Latent Variable in the Population.

1) A Ramsay Curve IRT Model (RC-IRT)

2) A Heteroskedastic-Skew Model (HS)

Unipolar Constructs, Quasi-Traits, and Excess Zeros

3) A zero-inflated mixture Model (ZIM)

4) A Log-Logistic Model (LL)

The first two models were developed to address non-normal latent trait distributions and violations of homogeneity of error variance, respectively.

The second two models were developed to address modeling problems associated with “quasi-continuous” or “unipolar” constructs, which apply only to a subset of the population, or are meaningful at one end of the continuum only.

Quasi-Traits

Almost 30 years ago Reise and Waller (1990, p. 57) stated that some “personality traits may have an inherently quasi-categorical rather than a full range continuum structure.”

Observing that clinical assessment instruments have highly peaked information functions in the high (pathological) trait range and a notable lack of items that provide discriminations among individuals in low trait ranges, Reise and Waller (2007, p. 31) stated, “we believe that the peaked information function for many clinical scales reflects the quasi-trait status of many psychopathology constructs.

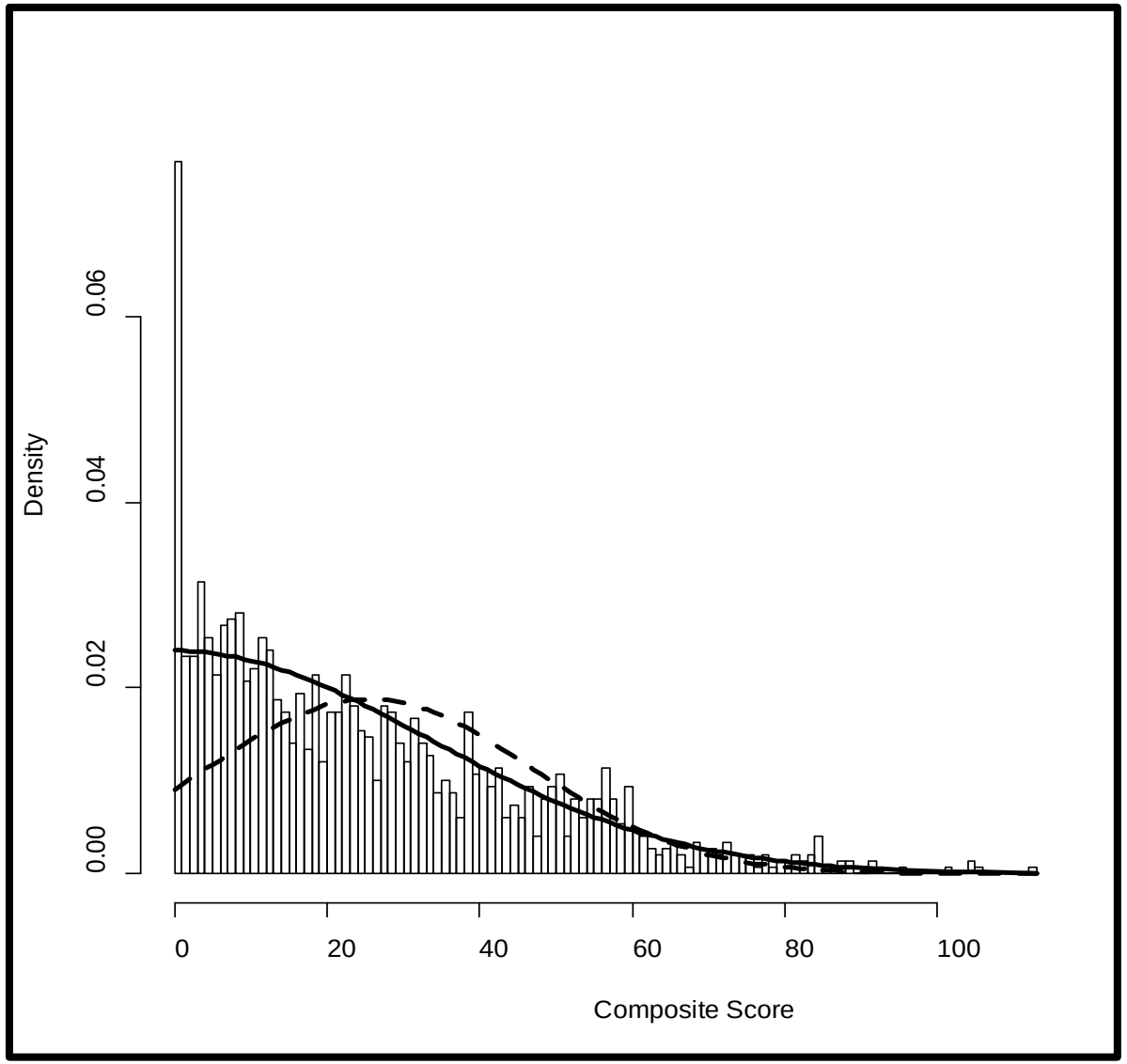
By the term ’quasi-trait,’ we mean that the trait is unipolar (relevant only in one direction) and that variation at the low end of the scale is less informative in both a substantive as well as a psychometric sense.”

Example Data and Model

The calibration sample consisted of 1498 non-clinical adults who responded to 29 items administered in the development of the PROMIS Anger measure.

As seen in the following figure, the distribution of summed scores appears to be more of a truncated-normal or half-normal distribution with zero-inflation; best fitting skewed normal (solid-line) and normal distributions (long-dashed line) are superimposed for illustrative purposes.

Histogram of Composite Scores for Anger Scale with Best Fitting Skewed Normal (solid line) and Normal Distribution (dashed line)



Item Content for the PROMIS Anger Item Pool.

0=Never,
1=Rarely,
2=Sometimes,
3=Often,
4=Always

Item #	PROMIS name	Content
1	edang01	When I was frustrated, I let it show
2	edang03	I was irritated more than people knew
3	edang04	I felt envious of others
4	edang05	I disagreed with people
5	edang06*	I made myself angry about something just by thinking about it
6	edang07*	I tried to get even when I was angry with someone
7	edang09	I felt angry
8	edang10	When I was mad at someone, I gave them the silent treatment
9	edang11	I felt like breaking things
10	edang15	I felt like I was ready to explode
11	edang16	When I was angry, I sulked
12	edang17	I felt resentful when I didn't get my way
13	edang18*	I felt guilty about my anger
14	edang21	I felt bitter about things
15	edang22	I felt that people were trying to anger me
16	edang25*	I stayed angry for hours
17	edang26	I held grudges towards others
18	edang28 *	I felt angrier than I thought I should
19	edang30	I was grouchy
20	edang31	I was stubborn with others
21	edang35	I felt annoyed
22	edang37	I had a bad temper
23	edang42	I had trouble controlling my temper
24	edang45*	I was angry when I was delayed
25	edang47*	Even after I expressed my anger, I had trouble forgetting about it
26	edang48	I felt like I needed help for my anger
27	edang54*	I was angry when something blocked my plans
28	edang55	I felt like yelling at someone
29	edang56	Just being around people irritated me

Graded Response Model

Item Slope, Location, and Intercept Parameter Estimates Under the Graded Response Model, Assuming a Normally Distributed Latent Trait.

	Slope	Location				Intercept			
	α	β_1	β_2	β_3	β_4	γ_1	γ_2	γ_3	γ_4
Item 1	1.71	-0.77	0.40	1.72	2.98	1.31	-0.69	-2.94	-5.09
Item 2	2.25	-0.40	0.46	1.52	2.48	0.90	-1.03	-3.42	-5.58
Item 3	1.80	0.26	1.18	2.21	3.26	-0.47	-2.12	-3.98	-5.86
Item 4	1.57	-1.21	0.04	1.96	3.60	1.90	-0.06	-3.08	-5.65
Item 5	2.65	-0.13	0.70	1.69	2.55	0.34	-1.86	-4.48	-6.75
Item 6	2.92	0.47	1.16	1.81	2.70	-1.38	-3.39	-5.28	-7.87
Item 7	2.85	-0.66	0.42	1.59	2.75	1.87	-1.20	-4.53	-7.86
Item 8	1.97	-0.17	0.69	1.68	2.77	0.34	-1.36	-3.32	-5.46
Item 9	3.14	0.65	1.13	1.77	2.65	-2.03	-3.55	-5.56	-8.32
Item 10	3.35	0.18	0.89	1.62	2.52	-0.61	-2.97	-5.42	-8.46
Item 11	2.76	-0.12	0.71	1.67	2.53	0.33	-1.95	-4.61	-6.98
Item 12	2.60	0.08	0.94	1.85	2.79	-0.20	-2.45	-4.81	-7.25
Item 13	2.25	0.01	0.76	1.76	2.52	-0.02	-1.72	-3.96	-5.67
Item 14	2.75	-0.05	0.75	1.63	2.84	0.14	-2.06	-4.48	-7.80
Item 15	2.62	0.32	0.97	1.97	2.94	-0.83	-2.54	-5.16	-7.69
Item 16	3.30	0.21	0.98	1.75	2.69	-0.70	-3.23	-5.78	-8.88
Item 17	2.62	0.13	0.90	1.82	2.55	-0.33	-2.34	-4.76	-6.67
Item 18	3.23	0.01	0.76	1.64	2.42	-0.03	-2.47	-5.30	-7.83
Item 19	2.49	-0.76	0.39	1.62	2.75	1.88	-0.98	-4.04	-6.86
Item 20	2.20	-0.28	0.76	1.90	3.11	0.62	-1.67	-4.17	-6.82
Item 21	2.19	-1.05	0.20	1.60	2.96	2.30	-0.45	-3.51	-6.47
Item 22	3.21	-0.08	0.78	1.68	2.62	0.25	-2.51	-5.38	-8.42
Item 23	3.27	0.21	1.01	1.84	2.54	-0.68	-3.31	-6.03	-8.31
Item 24	2.38	-0.24	0.64	1.69	2.72	0.57	-1.52	-4.01	-6.45
Item 25	3.00	-0.07	0.72	1.62	2.47	0.21	-2.17	-4.87	-7.41
Item 26	3.33	0.59	1.11	1.84	2.54	-1.98	-3.69	-6.12	-8.46
Item 27	2.68	-0.16	0.73	1.71	2.61	0.43	-1.96	-4.57	-7.00
Item 28	2.79	-0.17	0.65	1.65	2.53	0.47	-1.82	-4.60	-7.05
Item 29	2.42	0.69	1.34	2.06	2.79	-1.66	-3.23	-4.97	-6.75
Mean	2.63	-0.09	0.76	1.75	2.73	0.10	-2.08	-4.59	-7.09
SD	0.50	0.47	0.30	0.15	0.26	1.12	0.95	0.86	1.04
Mean[p]	2.17	-0.19	0.81	2.04	3.15				
SD[p]	0.43	0.65	0.55	0.43	0.47				

Note. α = slope, β = location, γ = intercept, [p] indicates Pilkonis et al. (2011) results.

Above the mean!

Average is -0.09

Graded Response Model

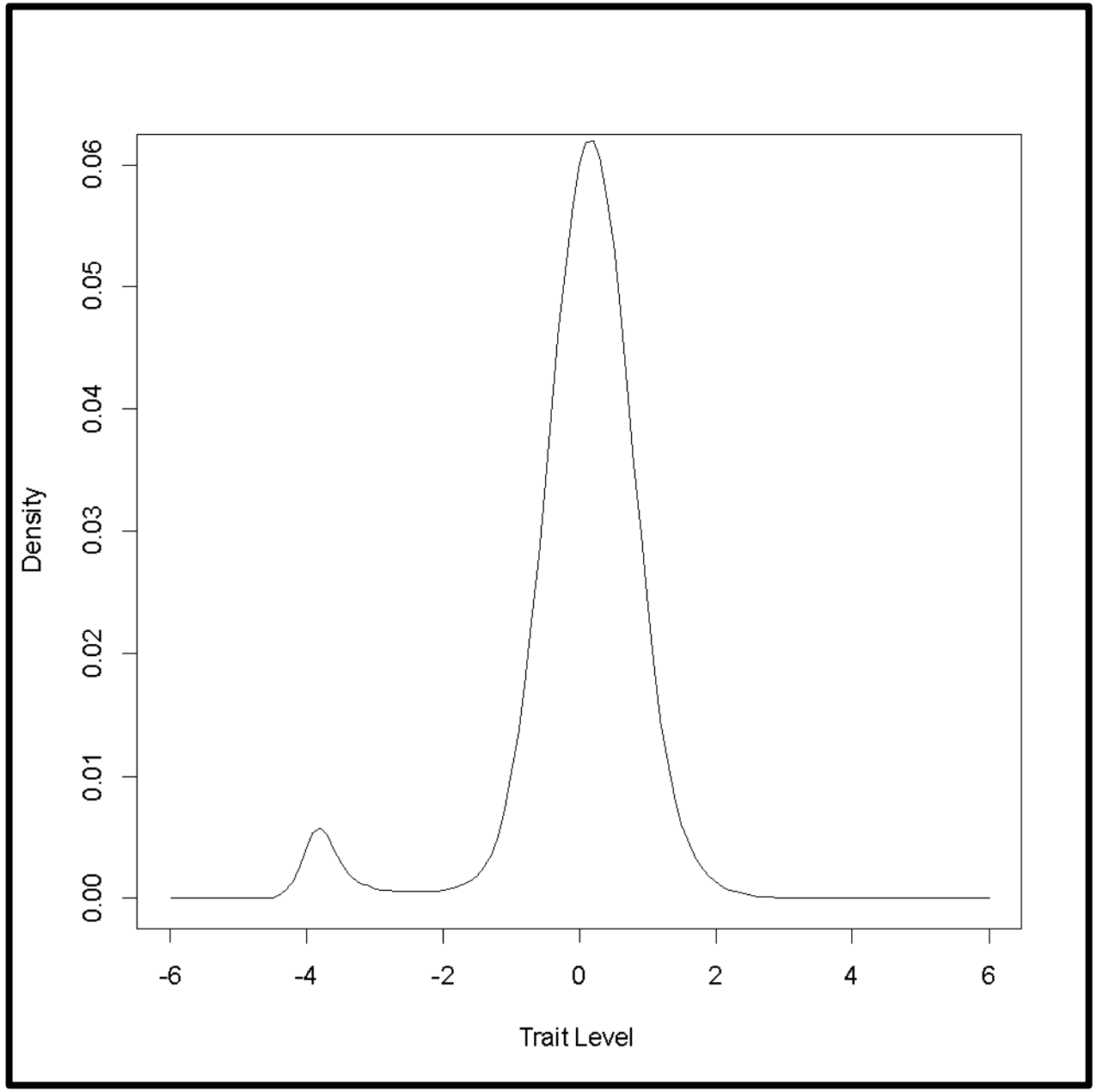
Ramsay Curve IRT

Ramsay Curve IRT GRM Parameter Estimates Based on 2 degrees and 6 knots.

2.63 in GRM

	α	β_1	β_2	β_3	β_4
Item 1	2.35	-0.47	0.38	1.33	2.23
Item 2	3.19	-0.19	0.42	1.16	1.84
Item 3	2.56	0.28	0.92	1.65	2.38
Item 4	2.09	-0.84	0.11	1.53	2.74
Item 5	3.79	0.01	0.59	1.28	1.88
Item 6	4.19	0.43	0.91	1.36	1.98
Item 7	4.05	-0.36	0.39	1.21	2.03
Item 8	2.79	-0.02	0.58	1.28	2.04
Item 9	4.50	0.55	0.89	1.33	1.95
Item 10	4.82	0.22	0.71	1.22	1.86
Item 11	3.95	0.02	0.59	1.27	1.87
Item 12	3.72	0.15	0.76	1.39	2.05
Item 13	3.22	0.10	0.63	1.33	1.86
Item 14	3.93	0.06	0.62	1.23	2.09
Item 15	3.75	0.32	0.77	1.47	2.15
Item 16	4.75	0.25	0.78	1.32	1.98
Item 17	3.75	0.19	0.72	1.37	1.88
Item 18	4.63	0.11	0.63	1.24	1.79
Item 19	3.50	-0.44	0.37	1.24	2.04
Item 20	3.12	-0.10	0.63	1.43	2.28
Item 21	3.02	-0.67	0.24	1.23	2.20
Item 22	4.61	0.04	0.64	1.27	1.93
Item 23	4.70	0.24	0.80	1.38	1.87
Item 24	3.38	-0.07	0.54	1.28	2.00
Item 25	4.30	0.05	0.60	1.23	1.82
Item 26	4.78	0.51	0.87	1.38	1.87
Item 27	3.83	-0.01	0.61	1.29	1.92
Item 28	4.00	-0.02	0.55	1.25	1.86
Item 29	3.46	0.58	1.03	1.53	2.05
Mean	3.75	0.03	0.63	1.33	2.01

The Latent Density Estimated by RC-LOG.



Heteroskedastic-Skew Model

$$y_i^* = \nu_i + \lambda_i \theta + \epsilon_i$$

Parameter Estimates from the Heteroskedastic-Skew Baseline Model

	λ	τ_3	τ_4	δ_0	δ_1^*	ν	α
Item 1	0.96	1.71	2.77	1.11	0	0.09	0.86
Item 2	1.02	1.58	2.47	0.65	0	0.12	1.57
Item 3	0.93	2.17	3.01	0.91	0	0.13	1.02
Item 4	0.97	1.92	3.38	1.18	0	0.10	0.82
Item 5	0.94	1.62	2.33	0.41	0	0.11	2.29
Item 6	0.97	1.83	2.63	0.39	0	0.10	2.49
Item 7	1.00	1.57	2.67	0.39	0	0.06	2.56
Item 8	1.01	1.70	2.67	0.84	0	0.07	1.2
Item 9	1.00	1.75	2.58	0.34	0	0.02	2.94
Item 10	0.96	1.60	2.42	0.28	0	0.12	3.43
Item 11	0.94	1.61	2.36	0.39	0	0.11	2.41
Item 12	0.88	1.71	2.47	0.39	0	0.11	2.26
Item 13	1.02	1.80	2.46	0.69	0	0.09	1.48
Item 14	0.84	1.45	2.40	0.32	0	0.13	2.62
Item 15	0.89	1.78	2.58	0.39	0	0.09	2.28
Item 16	1.02	1.78	2.66	0.31	0	0.07	3.29
Item 17	1.01	1.83	2.52	0.50	0	0.06	2.02
Item 18	1.03	1.70	2.44	0.34	0	0.09	3.03
Item 19	1.00	1.66	2.76	0.55	0	0.08	1.82
Item 20	1.01	1.96	3.08	0.71	0	0.09	1.42
Item 21	0.97	1.58	2.84	0.63	0	0.09	1.54
Item 22	1.02	1.71	2.61	0.33	0	0.08	3.09
Item 23	0.97	1.78	2.38	0.29	0	0.08	3.34
Item 24	0.88	1.52	2.36	0.45	0	0.10	1.96
Item 25	0.97	1.58	2.32	0.36	0	0.07	2.69
Item 26	0.94	1.78	2.39	0.27	0	0.10	3.48
Item 27	0.98	1.67	2.48	0.45	0	0.06	2.18
Item 28	0.94	1.54	2.32	0.38	0	0.06	2.47
Item 29	0.88	1.93	2.51	0.46	0	0.15	1.91
Mean	0.96	1.72	2.58	0.51	0	0.09	2.22
SD	0.05	0.15	0.25	0.24	0	0.03	0.77

Note. * fixed parameter. λ = regression weight; τ = threshold; δ_0 is the residual, δ_1 is the heteroscedasticity parameter; and, α is the IRT slope = λ/δ_0.

Heteroscedasticity

Error Variance

Parameter Estimates from the Heteroskedastic-Skew Full Model

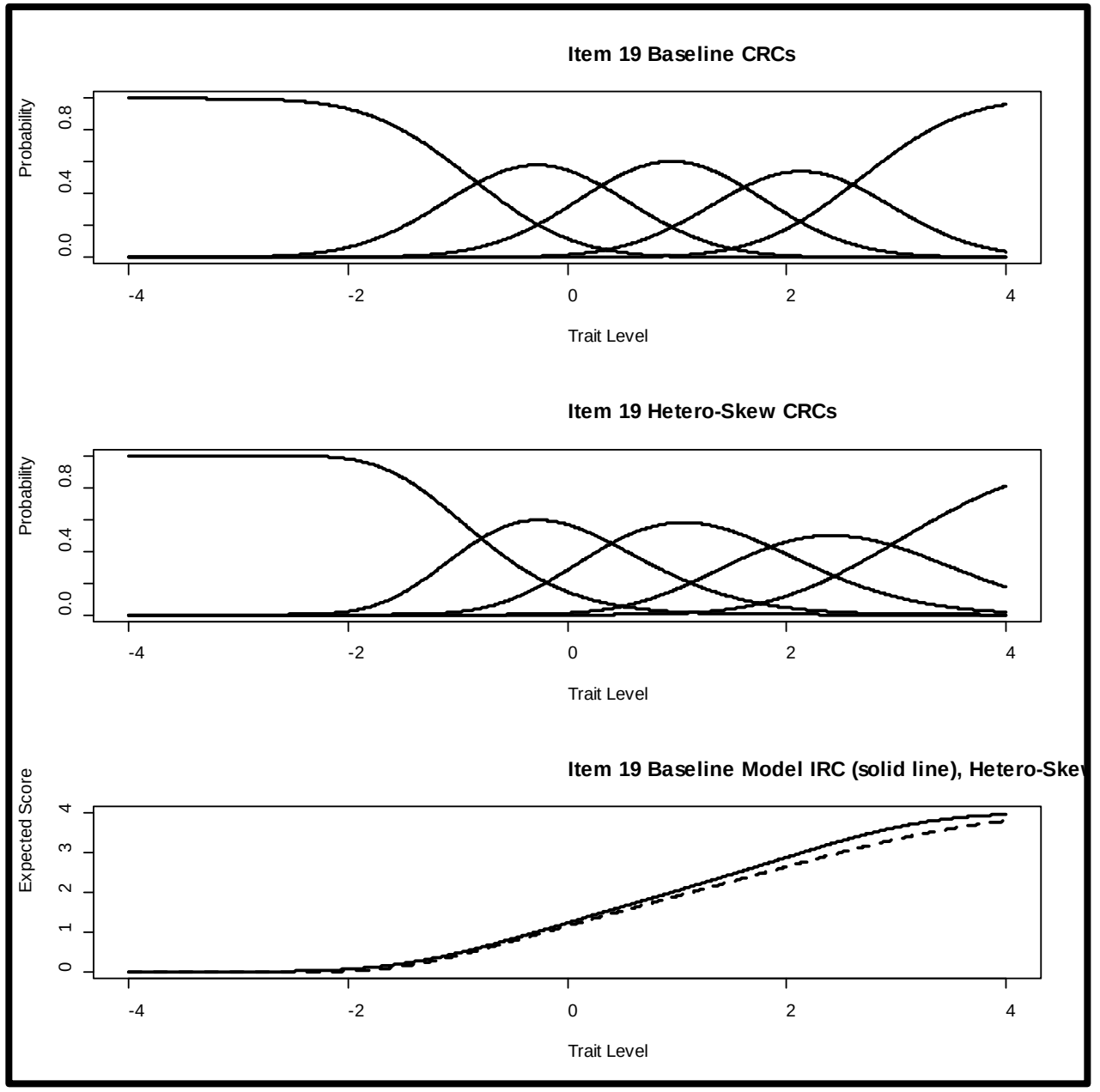
	λ	τ_3	τ_4	δ_0	δ_1	ν	α
Item 1	0.89	1.65	2.63	1.11	-0.32	-0.06	0.80
Item 2	0.95	1.54	2.36	0.65	-0.23	-0.02	1.46
Item 3	0.90	2.15	2.97	0.93	-0.11	-0.01	0.97
Item 4	0.91	1.90	3.29	1.18	-0.06	-0.03	0.77
Item 5	0.89	1.56	2.20	0.44	-0.43	-0.04	2.02
Item 6	0.91	1.85	2.65	0.35	0.28	0.01	2.60
Item 7	0.95	1.65	2.83	0.39	0.45	-0.03	2.44
Item 8	0.96	1.70	2.67	0.83	0.03	-0.05	1.16
Item 9	0.95	1.75	2.57	0.34	0.09	-0.10	2.79
Item 10	0.93	1.56	2.27	0.32	-0.55	-0.05	2.91
Item 11	0.89	1.57	2.24	0.42	-0.33	-0.04	2.12
Item 12	0.84	1.71	2.46	0.38	0.08	0.00	2.21
Item 13	0.97	1.79	2.43	0.70	-0.12	-0.05	1.39
Item 14	0.80	1.42	2.27	0.34	-0.30	0.00	2.35
Item 15	0.85	1.78	2.54	0.40	-0.06	-0.03	2.12
Item 16	0.98	1.76	2.58	0.33	-0.18	-0.07	2.97
Item 17	0.97	1.79	2.42	0.54	-0.32	-0.10	1.8
Item 18	0.98	1.68	2.38	0.34	-0.11	-0.05	2.88
Item 19	0.96	1.74	2.97	0.55	0.48	-0.01	1.75
Item 20	0.95	1.97	3.09	0.71	0.06	-0.03	1.34
Item 21	0.92	1.61	2.89	0.64	0.12	-0.02	1.44
Item 22	0.97	1.66	2.47	0.35	-0.33	-0.07	2.77
Item 23	0.94	1.74	2.29	0.34	-0.43	-0.08	2.76
Item 24	0.84	1.48	2.21	0.47	-0.37	-0.04	1.79
Item 25	0.92	1.52	2.19	0.39	-0.40	-0.08	2.36
Item 26	0.89	1.79	2.40	0.25	0.21	0.00	3.56
Item 27	0.92	1.60	2.30	0.48	-0.42	-0.10	1.92
Item 28	0.90	1.47	2.12	0.41	-0.54	-0.10	2.20
Item 29	0.86	1.92	2.49	0.50	-0.14	0.01	1.72
Mean	0.92	1.70	2.52	0.52	-0.14	-0.04	2.05
SD	0.05	0.16	0.30	0.24	0.28	0.03	0.71

Note. * fixed parameter. λ = regression weight; τ = threshold; δ_0 is the residual, δ_1 is the heteroscedasticity parameter; and, α is the IRT slope = λ/δ_0.

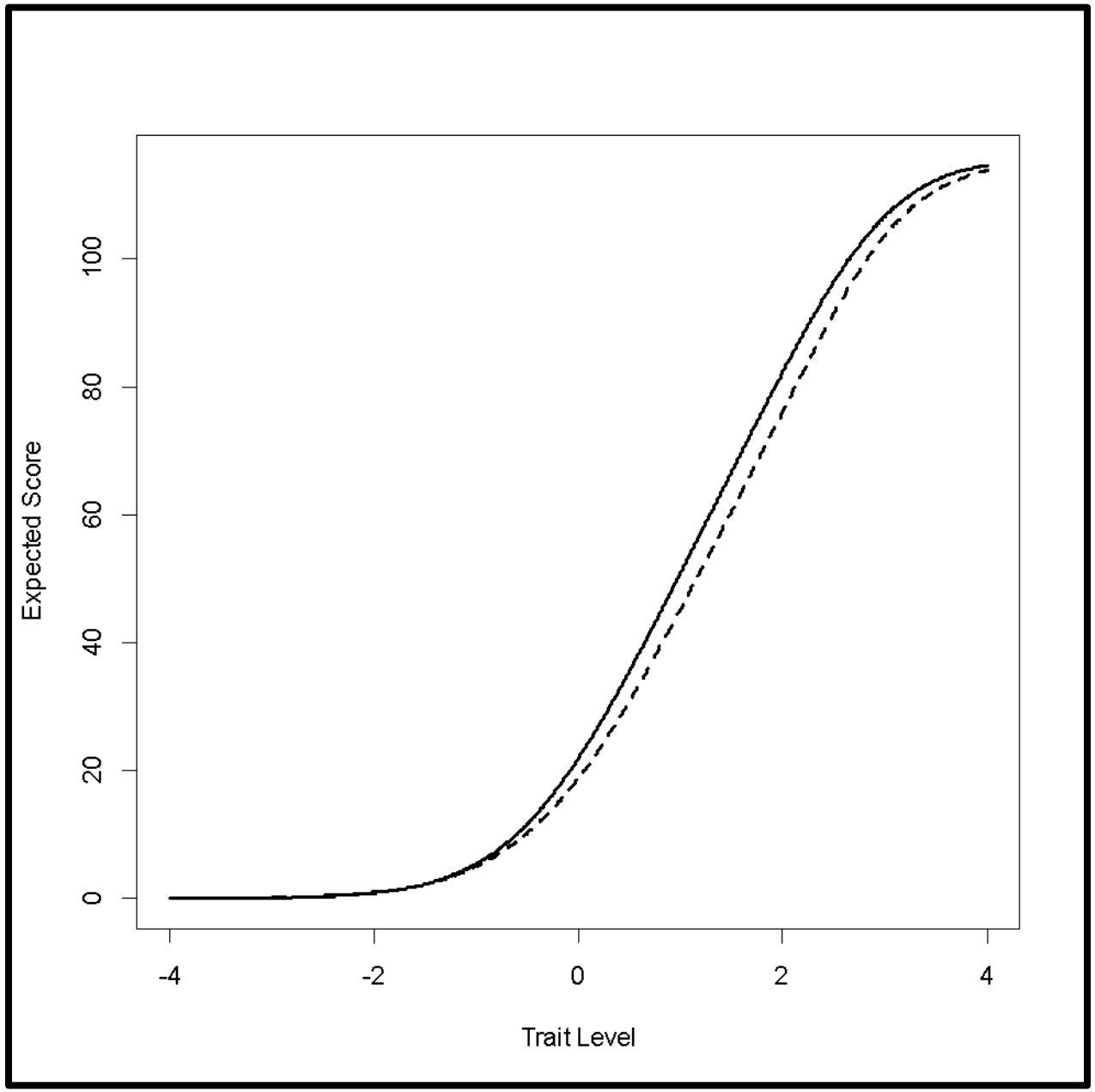
Skew Parameter = 0.28

The chi-square difference between the baseline and full model was 122.93 on 30 df, which is significant at p <= .01.

CRCs and IRCs for Item 19 under Baseline Model and HS Model.



Test Response Curves for Baseline (solid line) and HS (dashed line) Models.



Zero Inflated Mixture Model

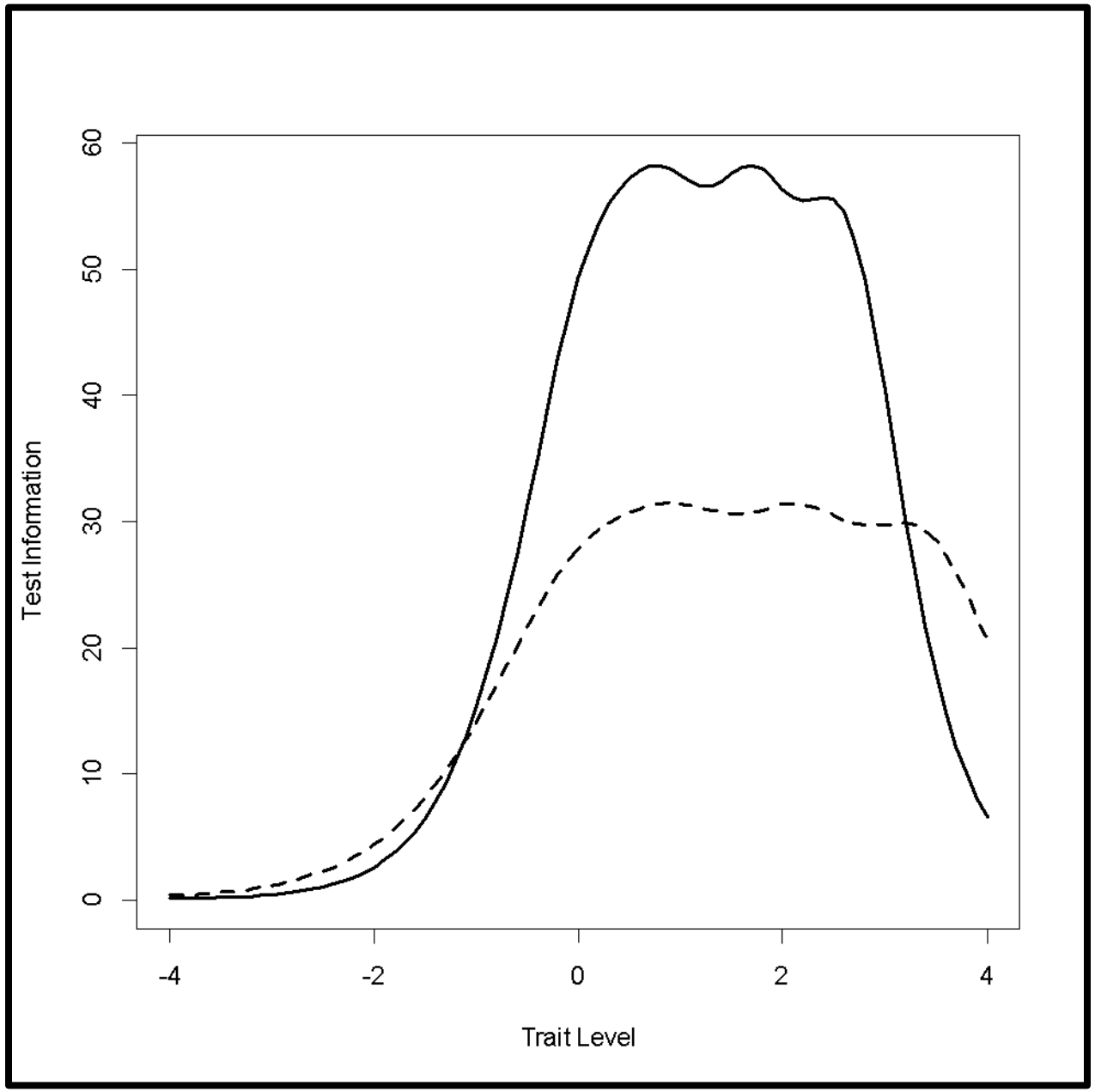
Item Slope, Location, and Intercept Parameter Estimates Under the Mixture Model, Assuming a Normally Distributed Latent Trait.

Lower than GRM

	Slope	Location				Intercept			
	α	β_1	β_2	β_3	β_4	γ_1	γ_2	γ_3	γ_4
Item 1	1.23	-1.21	0.41	2.22	3.95	1.49	-0.50	-2.73	-4.86
Item 2	1.66	-0.67	0.49	1.90	3.19	1.11	-0.81	-3.15	-5.30
Item 3	1.36	0.21	1.43	2.81	4.20	-0.29	-1.94	-3.82	-5.71
Item 4	1.08	-1.94	-0.11	2.61	4.94	2.10	0.12	-2.82	-5.34
Item 5	1.98	-0.30	0.81	2.12	3.27	0.59	-1.60	-4.20	-6.47
Item 6	2.18	0.50	1.41	2.28	3.47	-1.09	-3.07	-4.97	-7.56
Item 7	2.10	-1.00	0.43	1.99	3.56	2.10	-0.90	-4.18	-7.48
Item 8	1.44	-0.36	0.80	2.14	3.61	0.52	-1.15	-3.08	-5.20
Item 9	2.30	0.74	1.38	2.24	3.43	-1.70	-3.17	-5.15	-7.89
Item 10	2.44	0.11	1.05	2.02	3.26	-0.27	-2.56	-4.93	-7.95
Item 11	2.06	-0.29	0.81	2.09	3.24	0.60	-1.67	-4.31	-6.67
Item 12	1.94	-0.03	1.13	2.33	3.59	0.06	-2.19	-4.52	-6.96
Item 13	1.67	-0.12	0.89	2.22	3.24	0.20	-1.49	-3.71	-5.41
Item 14	2.05	-0.20	0.87	2.04	3.67	0.41	-1.78	-4.18	-7.52
Item 15	1.91	0.30	1.17	2.52	3.82	-0.57	-2.23	-4.81	-7.30
Item 16	2.43	0.15	1.17	2.20	3.47	-0.36	-2.84	-5.35	-8.43
Item 17	1.93	0.04	1.07	2.30	3.29	-0.08	-2.07	-4.44	-6.35
Item 18	2.36	-0.12	0.89	2.06	3.12	0.28	-2.10	-4.86	-7.36
Item 19	1.83	-1.15	0.40	2.04	3.57	2.10	-0.73	-3.73	-6.53
Item 20	1.63	-0.51	0.89	2.40	4.04	0.83	-1.45	-3.91	-6.59
Item 21	1.58	-1.59	0.14	2.03	3.87	2.51	-0.22	-3.21	-6.11
Item 22	2.38	-0.23	0.91	2.10	3.38	0.55	-2.17	-5.00	-8.04
Item 23	2.43	0.15	1.22	2.32	3.27	-0.36	-2.96	-5.64	-7.95
Item 24	1.77	-0.45	0.72	2.12	3.50	0.80	-1.27	-3.75	-6.20
Item 25	2.22	-0.22	0.84	2.03	3.17	0.49	-1.86	-4.51	-7.04
Item 26	2.42	0.67	1.36	2.33	3.28	-1.62	-3.29	-5.64	-7.94
Item 27	1.99	-0.35	0.84	2.14	3.35	0.70	-1.67	-4.26	-6.67
Item 28	2.06	-0.35	0.74	2.06	3.25	0.72	-1.52	-4.24	-6.70
Item 29	1.82	0.78	1.64	2.60	3.58	-1.42	-2.98	-4.73	-6.52
Mean	1.94	-0.26	0.89	2.22	3.54	0.36	-1.80	-4.27	-6.76
SD	0.37	0.65	0.40	0.21	0.39	1.08	0.90	0.79	0.98

Note. α = slope, β = location, γ = intercept.

A Comparison of Test Information for the GRM (solid line) and the Zero-Inflated Mixture Model (dashed line).



Log-Logistic Model

$$TRC_{ij} = P(x \geq j|\theta) = \frac{\lambda_{ij}\theta^{\eta_i}}{1 + \lambda_{ij}\theta^{\eta_i}}$$

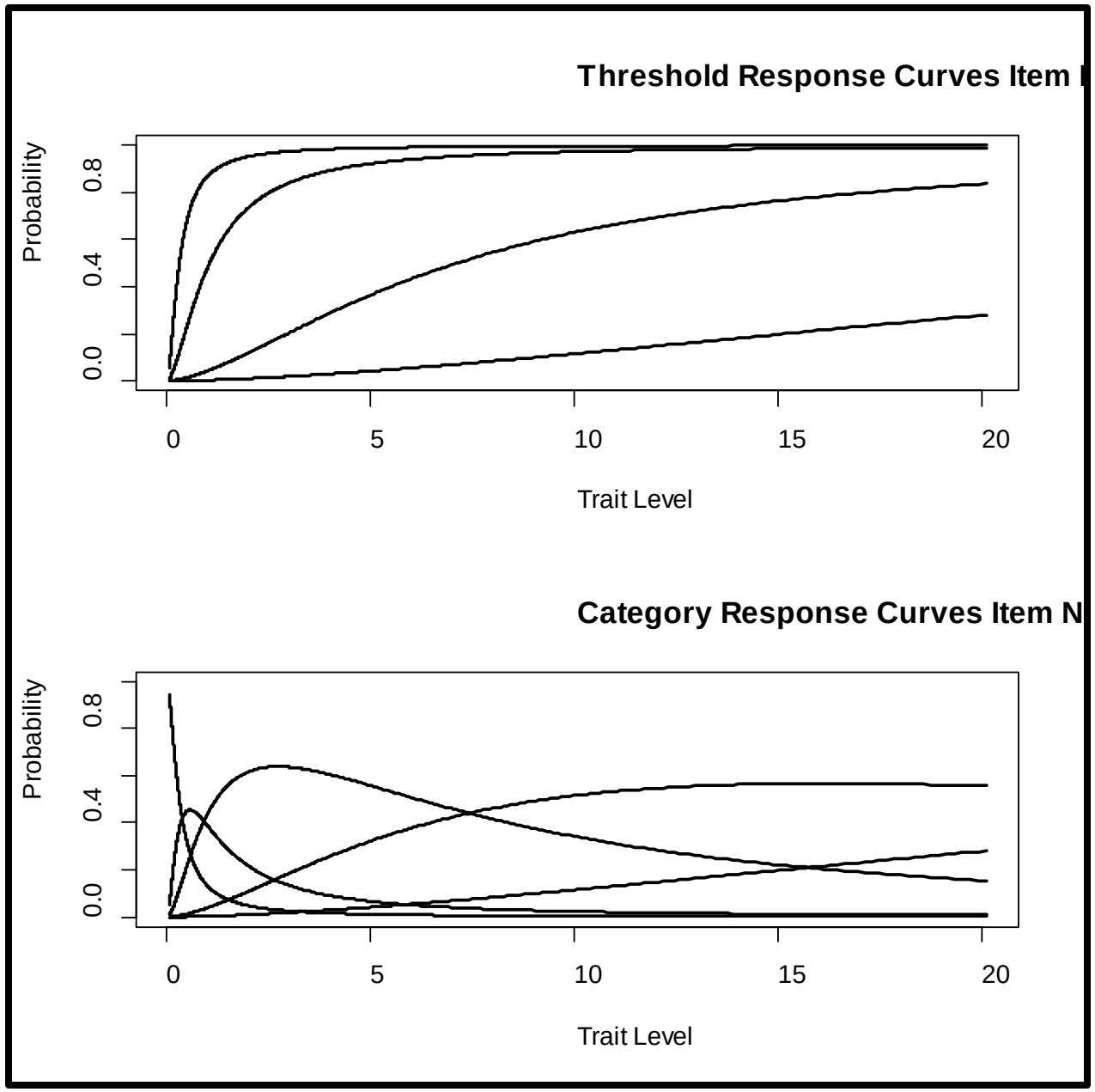
$$\delta_{ij} = \left(\frac{1}{\lambda_{ij}}\right)^{\frac{1}{\eta_{ij}}}$$

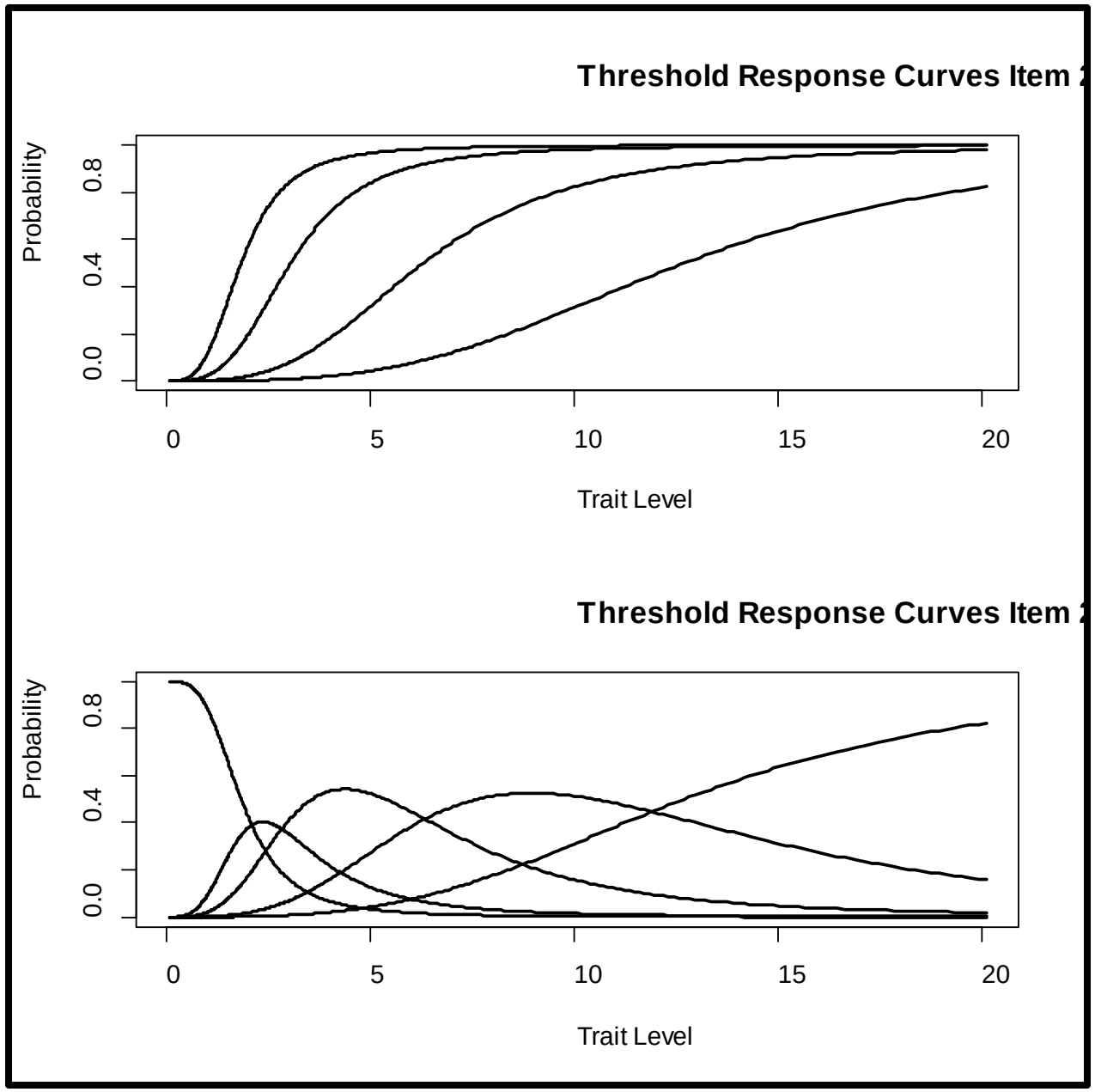
Item Slope, Location, and Intercept Parameter Estimates Under the Log-Logistic Model.

	Discrim	Easiness				Location			
	η	λ_1	λ_2	λ_3	λ_4	δ_1	δ_2	δ_3	δ_4
Item 1	1.71	3.706	0.502	0.053	0.006	0.463	1.492	5.585	19.688
Item 2	2.25	2.460	0.357	0.033	0.004	0.67	1.584	4.572	11.941
Item 3	1.80	0.625	0.120	0.019	0.003	1.297	3.254	9.116	26.05
Item 4	1.57	6.686	0.942	0.046	0.004	0.298	1.041	7.099	36.598
Item 5	2.65	1.405	0.156	0.011	0.001	0.878	2.014	5.419	12.807
Item 6	2.92	0.252	0.034	0.005	0	1.6	3.19	6.11	14.88
Item 7	2.85	6.488	0.301	0.011	0	0.517	1.522	4.904	15.643
Item 8	1.97	1.405	0.257	0.036	0.004	0.844	1.994	5.366	15.959
Item 9	3.14	0.131	0.029	0.004	0	1.916	3.096	5.871	14.154
Item 10	3.35	0.543	0.051	0.004	0	1.197	2.435	5.053	12.429
Item 11	2.76	1.391	0.142	0.010	0.001	0.887	2.034	5.312	12.554
Item 12	2.60	0.819	0.086	0.008	0.001	1.083	2.56	6.36	16.281
Item 13	2.25	0.980	0.179	0.019	0.003	1.01	2.138	5.812	12.429
Item 14	2.75	1.150	0.127	0.011	0	0.951	2.117	5.104	17.116
Item 15	2.62	0.436	0.079	0.006	0	1.377	2.638	7.171	18.916
Item 16	3.30	0.497	0.040	0.003	0	1.234	2.664	5.755	14.732
Item 17	2.62	0.719	0.096	0.009	0.001	1.139	2.46	6.172	12.807
Item 18	3.23	0.97	0.085	0.005	0	1.01	2.138	5.155	11.246
Item 19	2.49	6.554	0.375	0.018	0.001	0.468	1.477	5.053	15.643
Item 20	2.20	1.859	0.188	0.015	0.001	0.756	2.138	6.686	22.421
Item 21	2.19	9.974	0.638	0.030	0.002	0.35	1.221	4.953	19.298
Item 22	3.21	1.284	0.081	0.005	0	0.923	2.181	5.366	13.736
Item 23	3.27	0.507	0.037	0.002	0	1.234	2.746	6.297	12.68
Item 24	2.38	1.768	0.219	0.018	0.002	0.787	1.896	5.419	15.18
Item 25	3.00	1.234	0.114	0.008	0.001	0.932	2.054	5.053	11.822
Item 26	3.33	0.138	0.025	0.002	0	1.804	3.034	6.297	12.68
Item 27	2.68	1.537	0.141	0.010	0.001	0.852	2.075	5.529	13.599
Item 28	2.79	1.600	0.162	0.010	0.001	0.844	1.916	5.207	12.554
Item 29	2.42	0.190	0.040	0.007	0.001	1.994	3.819	7.846	16.281
Mean	2.631	1.976	0.193	0.014	0.001	1.011	2.239	5.85	15.935
SD	0.501	2.407	0.206	0.013	0.001	0.434	0.644	0.991	5.234

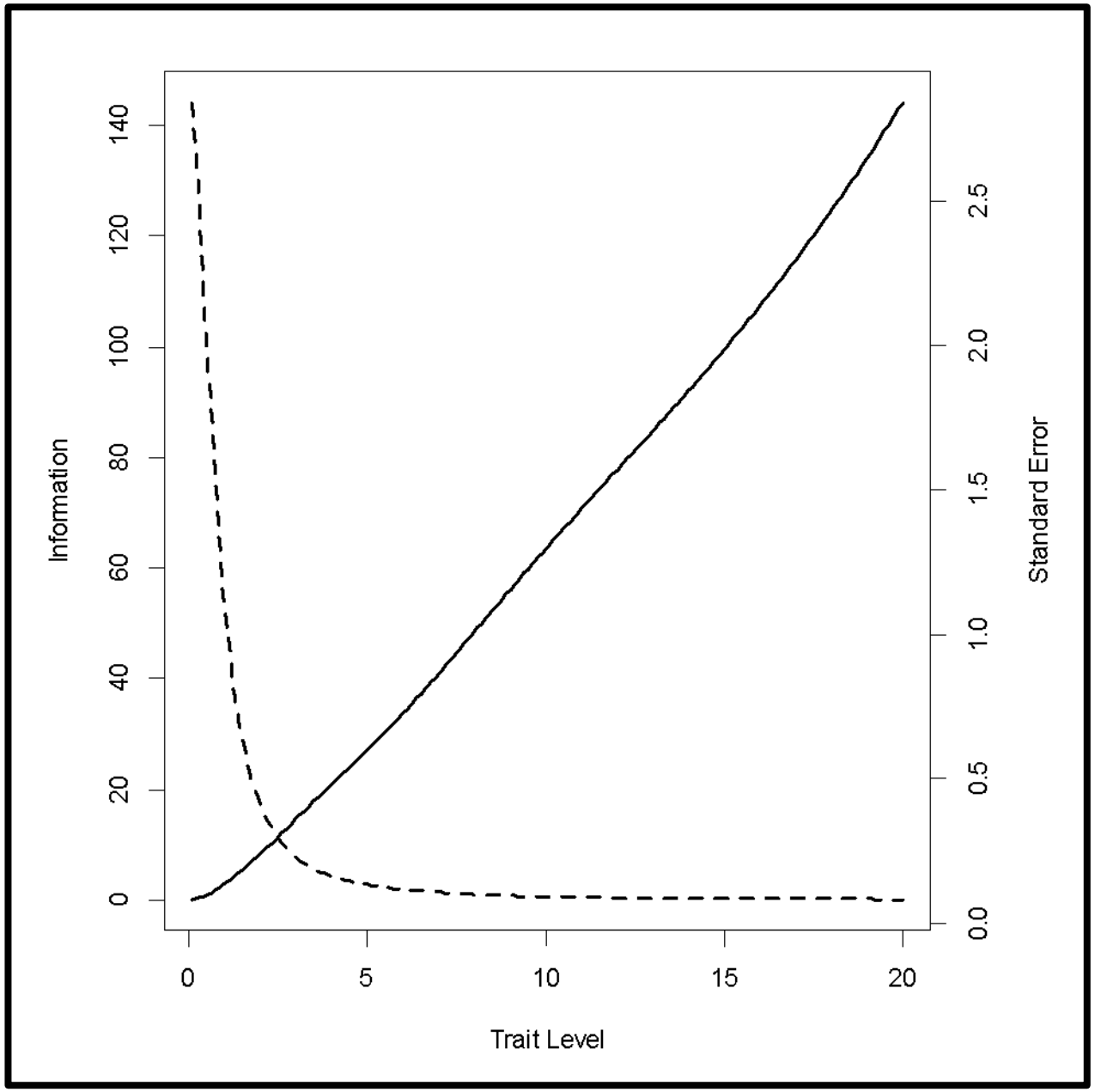
Note. η = slope, λ = easiness, δ = location

The point on the latent trait continuum where the probability of endorsing is .50


Threshold Response Curves Item I
Probability
0.0
0.4
0.8
0
5
10
15
20
Trait Level
Category Response Curves Item N
Probability
0.0
0.4
0.8
0
5
10
15
20
Trait Level


Threshold Response Curves Item 2
Probability
0.0
0.4
0.8
0
5
10
15
20
Trait Level
Threshold Response Curves Item 2
Probability
0.0
0.4
0.8
0
5
10
15
20
Trait Level

Test Information (dashed line) and Standard Errors (solid line) in the Log-Logistic Model.



Limitations

RC-IRT

Can only be expected to work if there is a reasonable non-normal latent distribution. If there are excess zeros, or extreme skew, then results may be highly erroneous

HS Model

Based on a skewed-normal distribution which limits to a skewness of 1.0.

Unclear what the interpretation of heterogeneous skew is

No readily accessible parameter estimation routines

Limitations

Mixture-IRT

Partitions most zero responses to a degenerate class (no scores), but some zeros are considered part of traited class

Assumes a normal distribution for the latent trait in one class

Log-Logistic

Anchors scale at zero, no z-scores (can also be a strength)

Doesn’t solve excess zeros problem, parameters are still inflated.

Information function has strange characteristics