Supplementary Information: The representational instability in the generalization of fear learning

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This document contains additional modelling information and results to the manuscript: **The representational instability in the generalization of fear learning**. The raw data and the codes for analysis can be accessed from https://osf.io/8qxu3/. Contact Kenny Yu (kenny.yu@kuleuven.be) for more information or questions about the manuscript. [+]Francis Tuerlinckx and Jonas Zaman share the last authorship for this work.

Supplementary Note 1

Here, we provide the estimated values of μ (mean) and σ (standard deviation) obtained from 5 blocks of data. These estimates are derived from both the size estimation data collected during acquisition and generalization tasks, as well as the size reproduction and estimation data gathered during the memory task. The statistics are presented along with their corresponding quantiles, specifically the 50th percentile [2.5th percentile, 97.5th percentile].

μ: Size estimation data in acquisition and generalization tasks

Stimulus	Block				
	1	2	3	4	5
S3 (S3 as CS+)	59.14 [57.64, 60.44]	62.40 [61.45, 64.03]	65.06 [64.27, 66.09]	67.74 [66.75, 68.73]	70.40 [68.96, 71.70]
S3 [S3 as CS-]	57.46 [55.90, 59.02]	58.44 [57.22, 59.74]	59.40 [58.24, 60.98]	60.27 [58.71, 61.87]	61.03 [58.78, 63.10]
S8 [S8 as CS+]	120.13 [117.51, 123.55]	116.71 [114.75, 118.60]	113.42 [110.70, 114.91]	110.92 [109.26, 112.47]	108.39 [106.41, 110.53]
S8 [S8 as CS-]	116.17 [113.98, 118.43]	115.20 [113.04, 116.89]	114.41 [112.66, 115.91]	113.64 [111.84, 115.43]	112.91 [110.55, 115.34]

Supplementary Table 1. The median estimations and 95% credible intervals of the estimated μ of the perceptual estimation in the acquisition and generalization stage.

μ: Size reproduction data in the memory task

	Block				
Stimulus	1	2	3	4	5
S3 (S3 as CS+)	60.58 [59.00, 62.16]	60.05 [58.88, 61.22]	59.53 [58.44, 60.42]	59.14 [58.18, 60.31]	58.58 [57.23, 59.88]
S3 (S3 as CS-)	57.93 [55.80, 60.11]	57.67 [56.15, 59.70]	57.02 [55.57, 58.50]	56.47 [54.87, 58.08]	55.88 [53.72, 57.90]
S8 (S8 as CS+)	101.93 [99.00, 104.65]	102.47 [100.67, 104.77]	102.63 [101.14, 104.17]	102.88 [101.39, 104.44]	103.05 [100.92, 104.97]
S8 (S8 as CS-)	101.28 [96.94, 104.65]	105.41 [103.12, 108.80]	106.67 [104.82, 109.25]	108.14 [106.10, 110.41]	109.13 [106.42, 111.51]

Supplementary Table 2. The median estimations and 95% credible intervals of the estimated μ of the size reproduction in the memory task.

μ: Size estimation data in the memory task

	Block				
Stimulus	1	2	3	4	5
S3 (S3 as CS+)	60.79 [58.60, 63.02]	61.18 [59.58, 62.75]	61.66 [60.41, 62.88]	62.15 [60.81, 63.57]	62.53 [60.65, 64.44]
S3 (S3 as CS-)	55.81 [53.18, 58.37]	55.85 [53.93, 57.78]	55.82 [54.08, 57.62]	55.78 [53.66, 57.88]	55.74 [52.82, 58.60]
S8 (S8 as CS+)	117.68 [113.42, 121.98]	116.25 [113.29, 119.31]	114.77 [112.45, 117.03]	113.34 [110.97, 115.63]	111.96 [108.65, 115.11]
S8 (S8 as CS-)	114.60 [108.84, 119.70]	120.69 [117.12, 125.58]	121.84 [119.00, 125.93]	122.42 [119.41, 125.49]	123.09 [119.48, 126.31]

Supplementary Table 3. The median estimations and 95% credible intervals of the estimated μ of the size estimation in the memory task.

σ: Size estimation data in acquisition and generalization tasks

Stimulus	Block				
	1	2	3	4	5
S3 (S3 as CS+)	15.87 [14.92, 16.91]	18.77 [17.73, 19.95]	15.97 [15.05, 16.99]	17.72 [16.76, 18.78]	19.83 [18.76, 21.03]
S3 (S3 as CS-)	15.43 [14.32, 16.71]	14.31 [12.25, 15.77]	15.06 [13.70, 16.51]	15.42 [14.15, 17.28]	15.28 [13.77, 17.17]
S8 (S8 as CS+)	30.26 [28.30, 32.76]	27.48 [26.02, 29.18]	24.61 [22.75, 26.05]	23.35 [21.94, 24.66]	22.45 [21.04, 24.18]
S8 (S8 as CS-)	27.62 [26.09, 29.42]	25.12 [23.17, 26.56]	23.17 [21.32, 24.53]	21.67 [20.30, 23.22]	20.13 [18.60, 22.04]

Supplementary Table 4. The median estimations and 95% credible intervals of the estimated σ of the perceptual estimation in the acquisition and generalization stage.

σ: Size reproduction data in the memory task

Stimulus	Block				
	1	2	3	4	5
S3 (S3 as CS+)	16.22 [15.07, 17.46]	15.29 [14.48, 16.22]	14.40 [13.67, 15.20]	13.54 [12.80, 14.35]	12.73 [11.83, 13.70]
S3 (S3 as CS-)	16.61 [14.79, 18.54]	17.57 [16.26, 19.42]	17.87 [16.55, 19.96]	17.23 [15.88, 18.91]	16.34 [14.60, 18.20]
S8 (S8 as CS+)	23.46 [21.26, 26.28]	19.75 [17.64, 21.52]	17.96 [16.25, 19.46]	16.54 [14.99, 18.00]	15.95 [14.44, 17.91]
S8 (S8 as CS-)	26.59 [24.26, 29.31]	21.86 [19.80, 24.26]	22.48 [20.85, 24.34]	21.24 [19.53, 22.95]	21.37 [19.64, 23.40]

Supplementary Table 5. The median estimations and 95% credible intervals of the estimated σ of the size reproduction in the memory task.

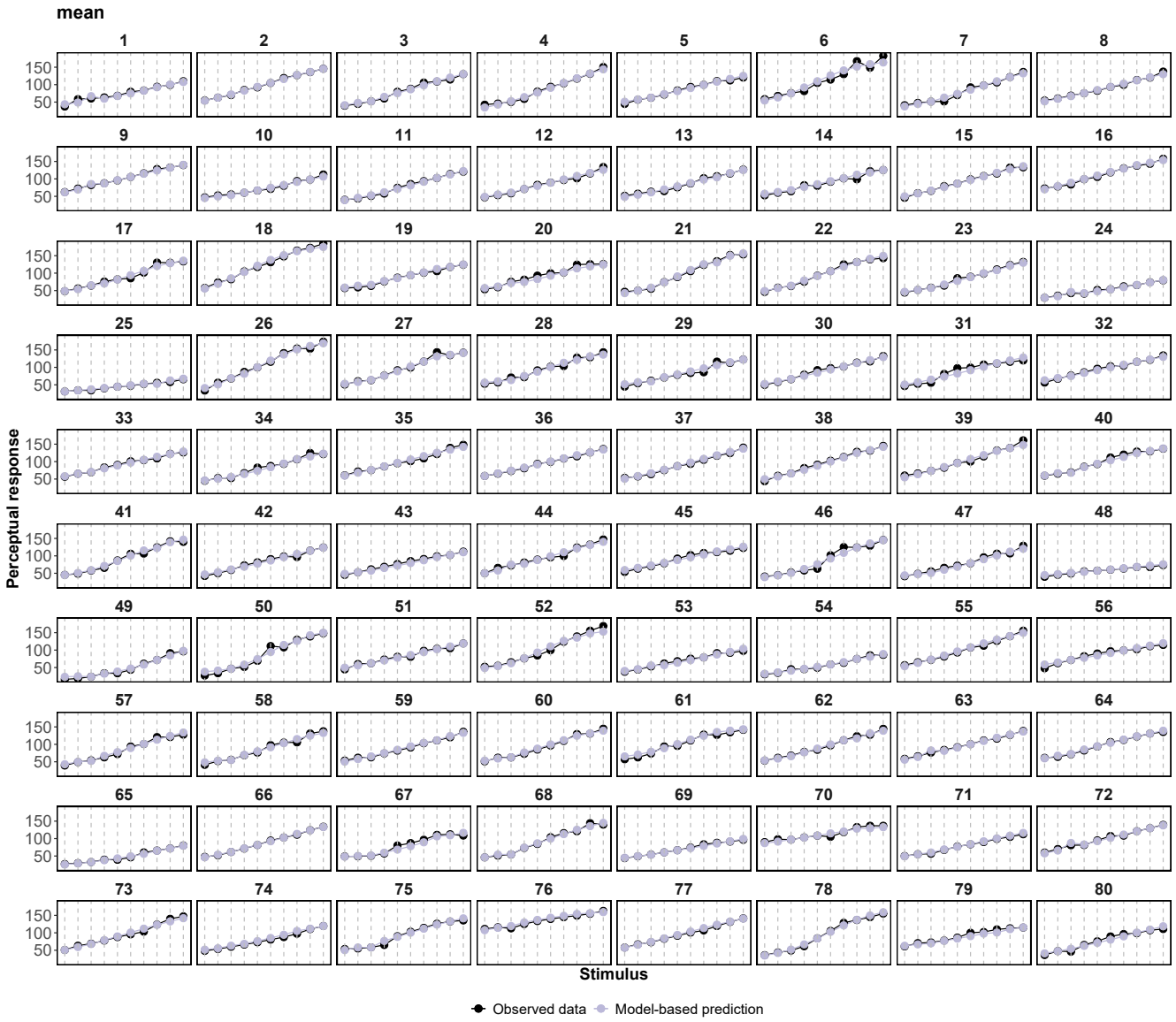
σ: Size estimation data in the memory task

Stimulus	Block				
	1	2	3	4	5
S3 (S3 as CS+)	22.85 [21.11, 25.13]	20.52 [18.79, 21.96]	19.26 [17.57, 20.55]	19.07 [17.89, 20.87]	17.73 [16.41, 19.24]
S3 (S3 as CS-)	19.03 [17.05, 21.40]	22.22 [20.10, 24.67]	26.92 [24.29, 30.25]	24.77 [22.48, 27.48]	22.27 [19.98, 25.07]
S8 (S8 as CS+)	37.08 [33.72, 41.46]	32.35 [29.79, 35.11]	28.07 [24.82, 30.44]	26.20 [24.07, 28.54]	24.26 [22.10, 27.01]
S8 (S8 as CS-)	36.59 [34.03, 39.83]	33.56 [31.28, 35.65]	31.08 [28.50, 32.82]	29.60 [27.95, 31.87]	27.58 [25.64, 29.80]

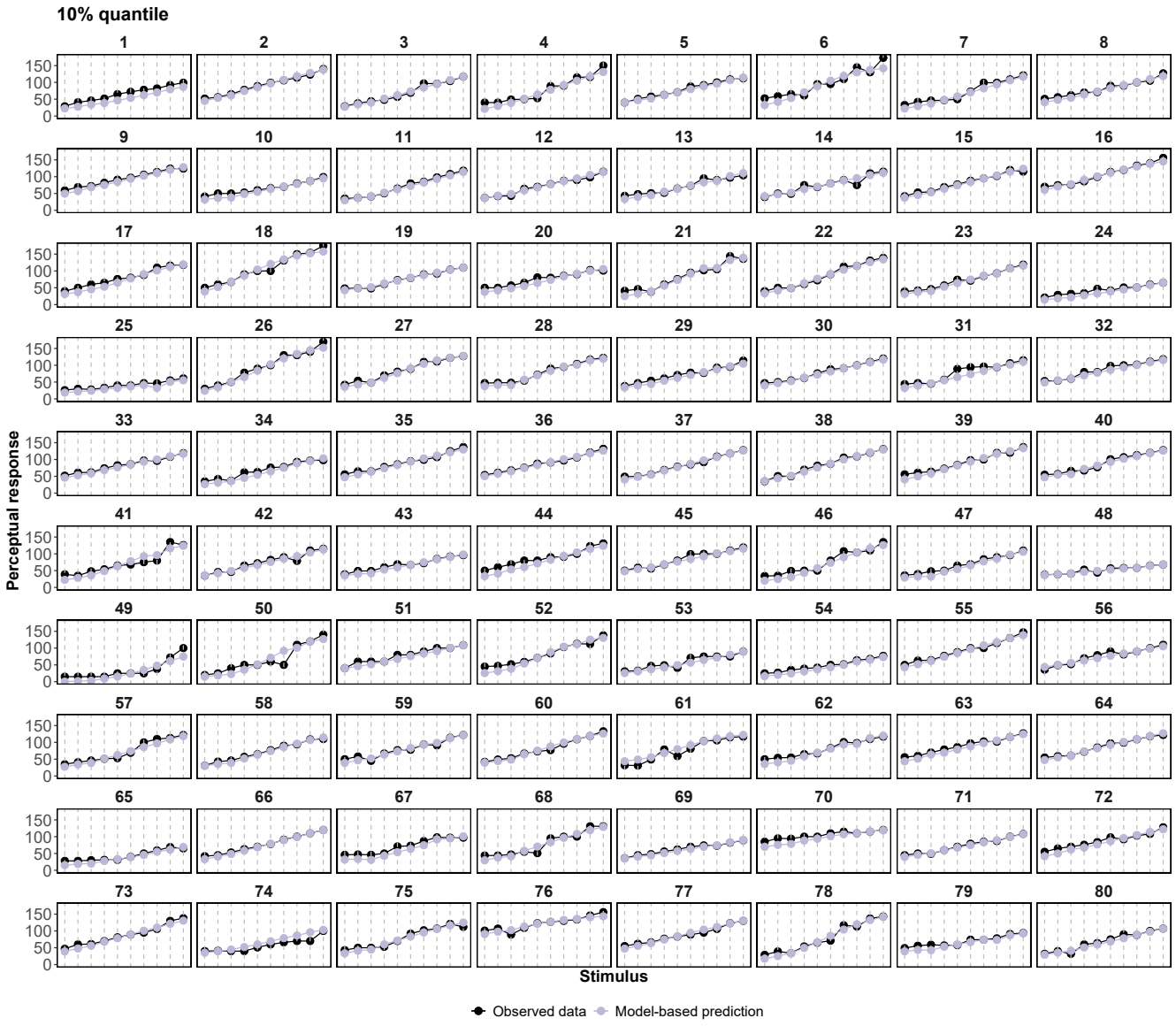
Supplementary Table 6. The median estimations and 95% credible intervals of the estimated σ of the size estimation in the memory task.

Supplementary Note 2

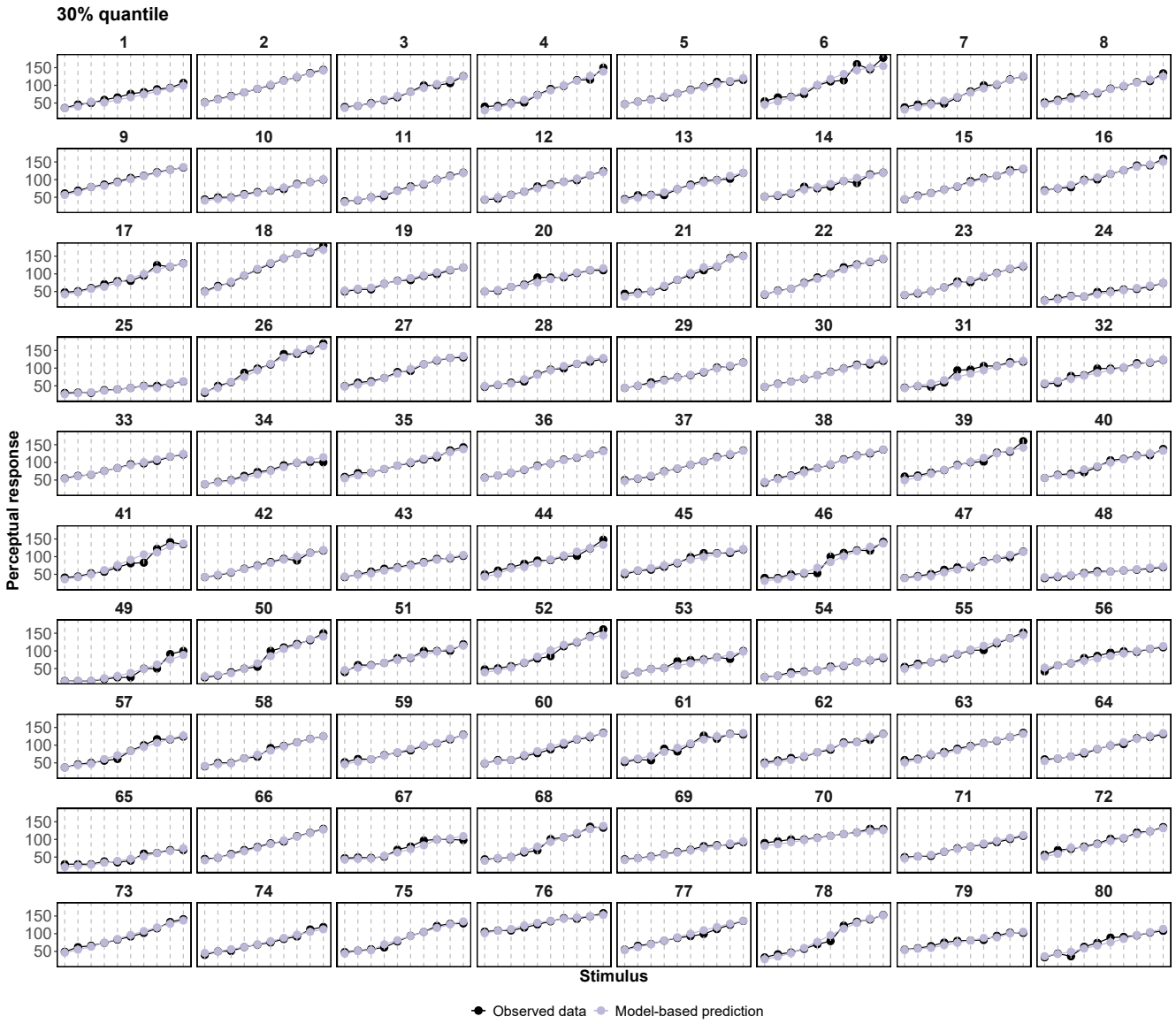
Here, we present the posterior predictive checks of both perceptual and generalization computational models. The posterior predictive checks aim to assess the adequacy of the models by comparing the distribution of simulated data generated from the posterior predictive distribution to the observed data, thereby evaluating how well the models capture the underlying processes and patterns in the data. We show the comparison across different statistical quantiles: mean, 10%, 30%, 50%, 70%, 90%.



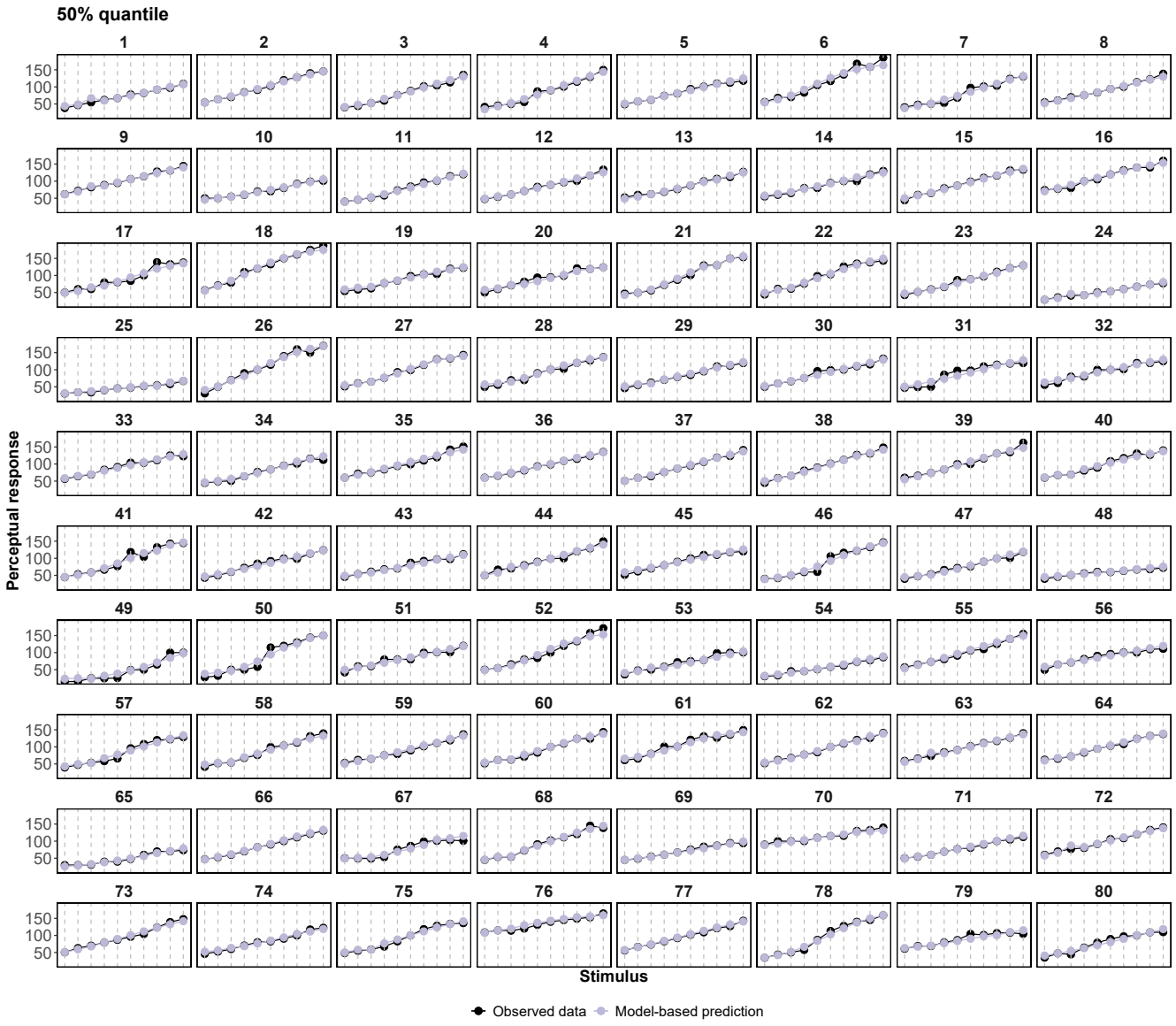
Supplementary Figure 1. Posterior predictive checks for the perceptual model with mean. The comparison involves evaluating the mean of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



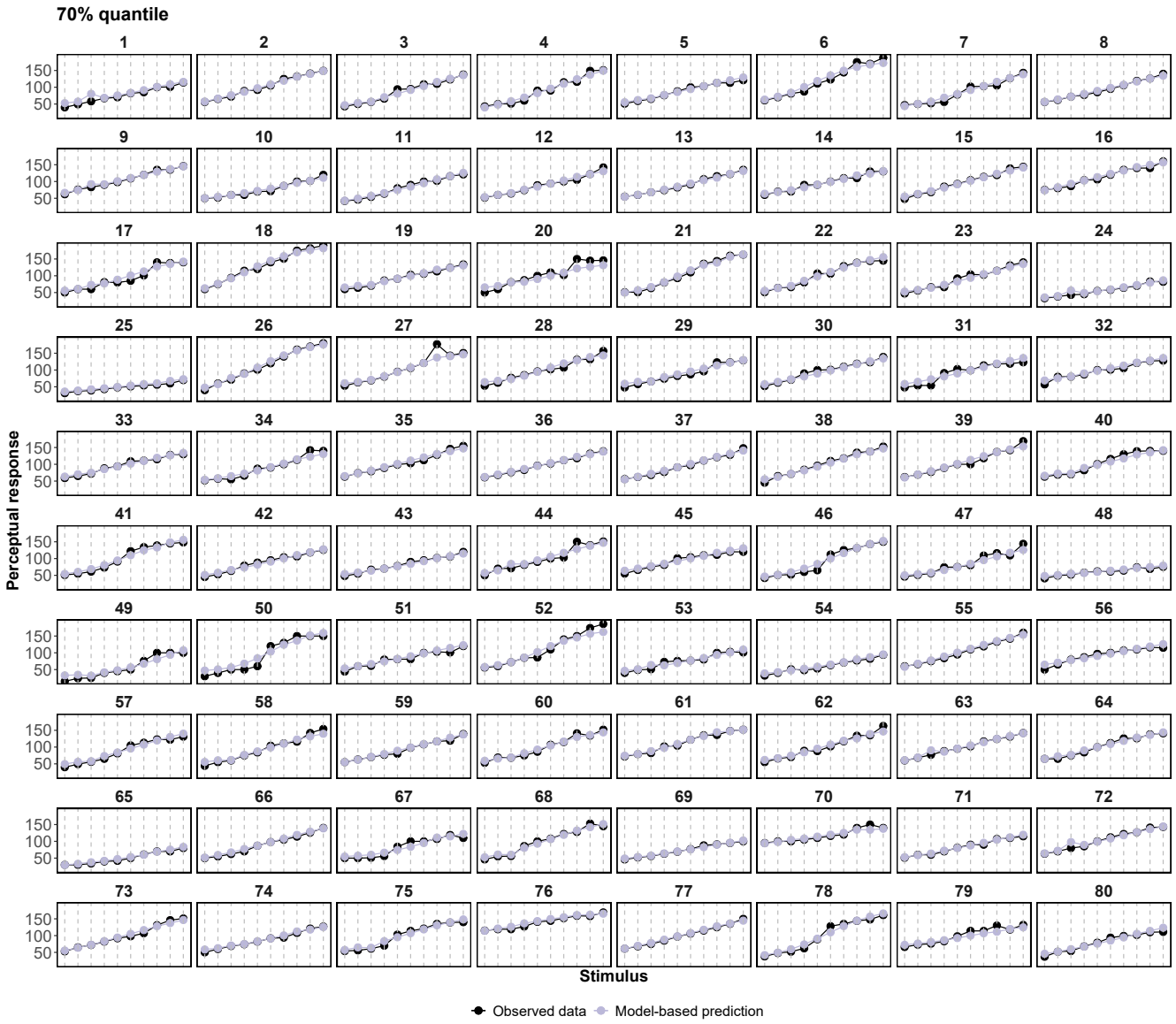
Supplementary Figure 2. Posterior predictive checks for the perceptual model with 10% quantile. The comparison involves evaluating the 10% quantile of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



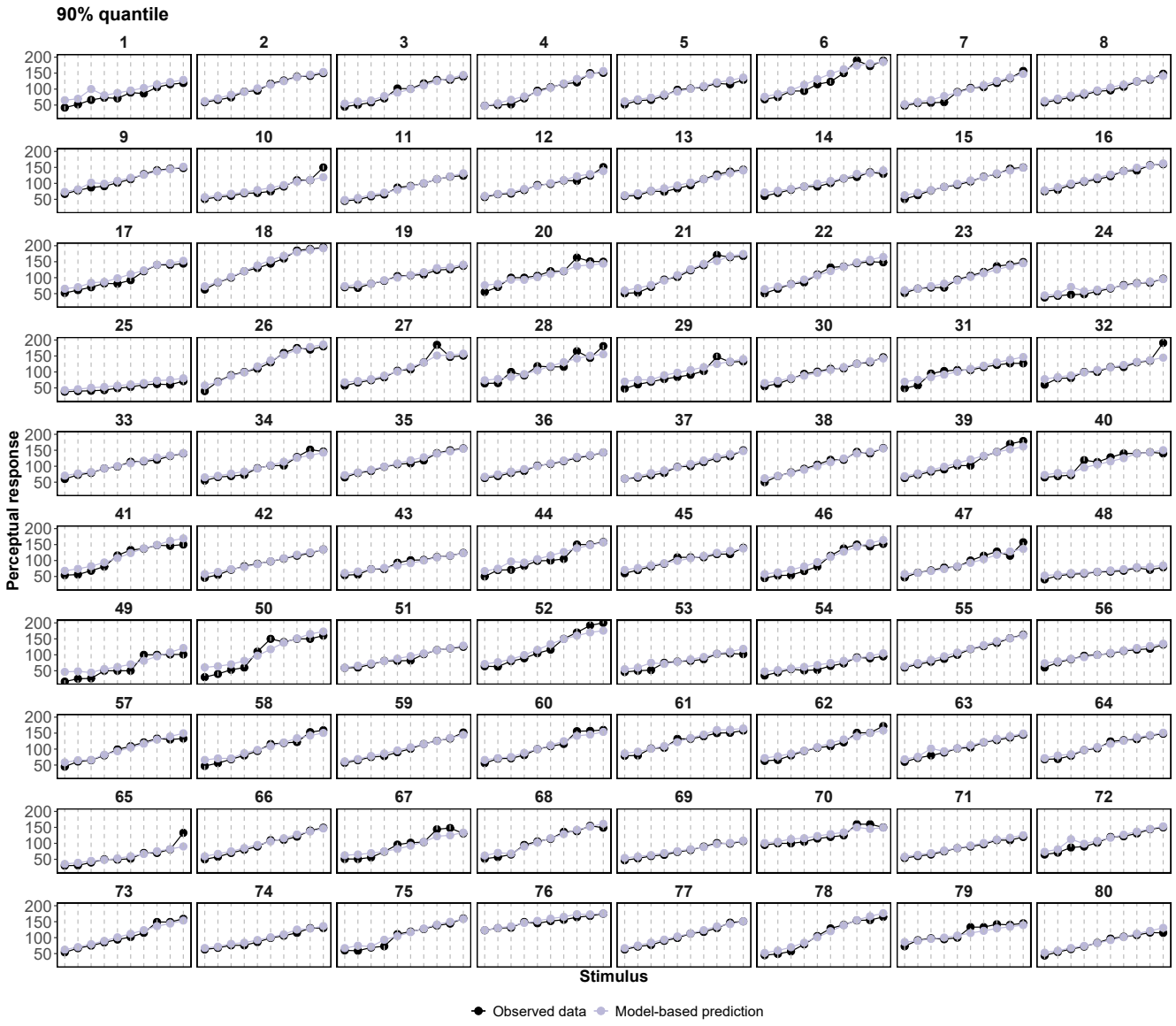
Supplementary Figure 3. Posterior predictive checks for the perceptual model with 30% quantile. The comparison involves evaluating the 30% quantile of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



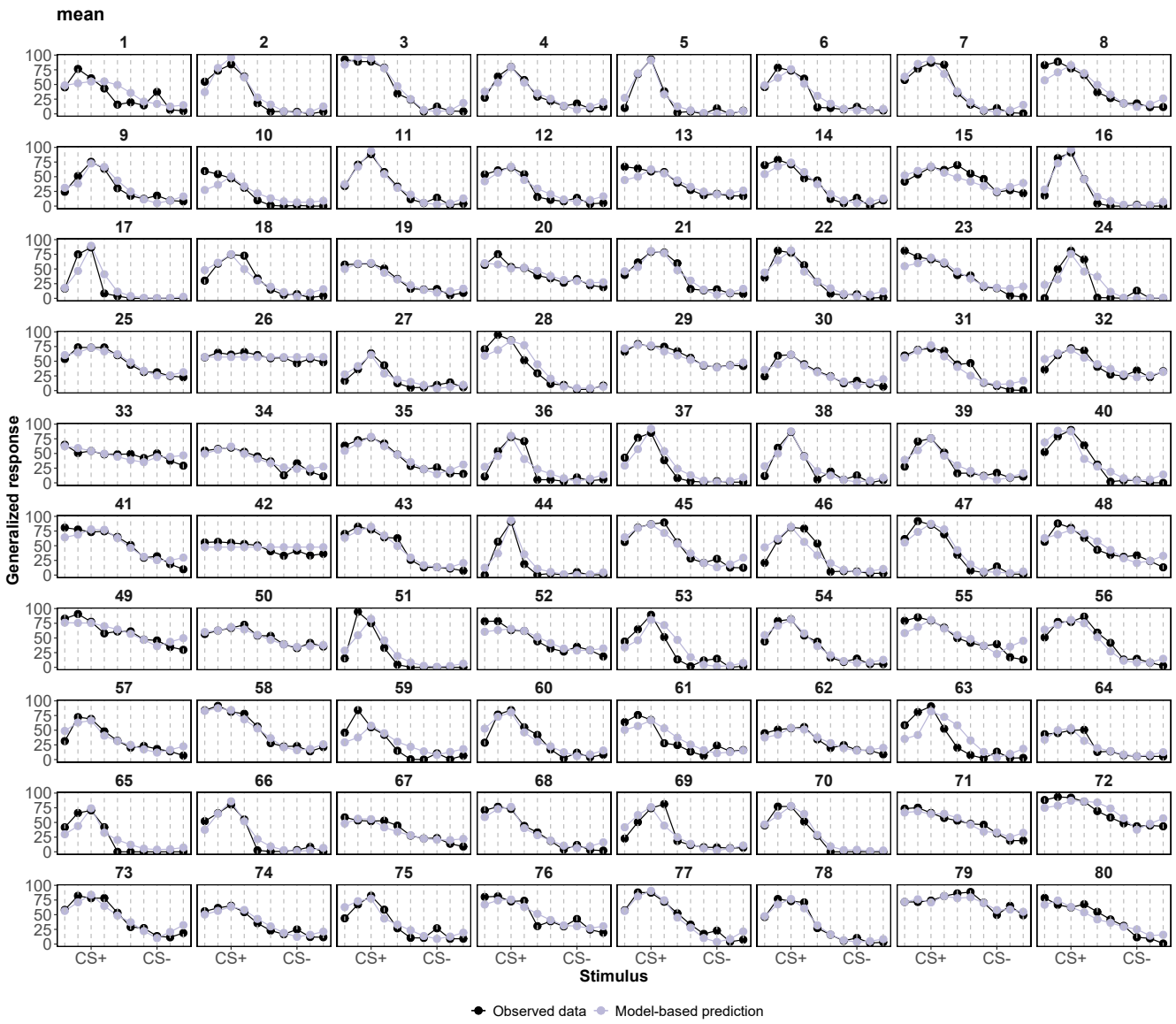
Supplementary Figure 4. TPosterior predictive checks for the perceptual model with 50% quantile. The comparison involves evaluating the 50% quantile of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



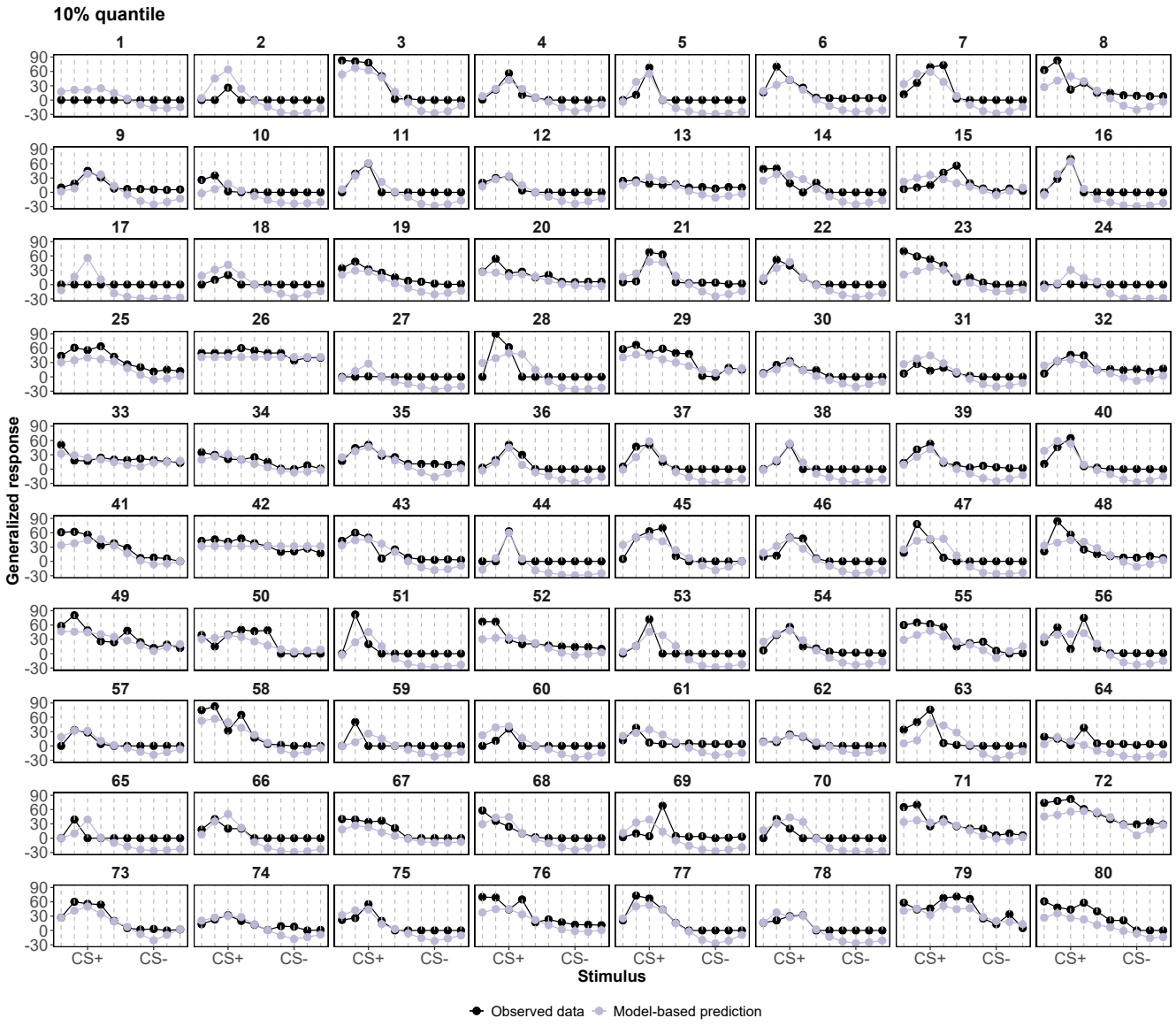
Supplementary Figure 5. Posterior predictive checks for the perceptual model with 70% quantile. The comparison involves evaluating the 70% quantile of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



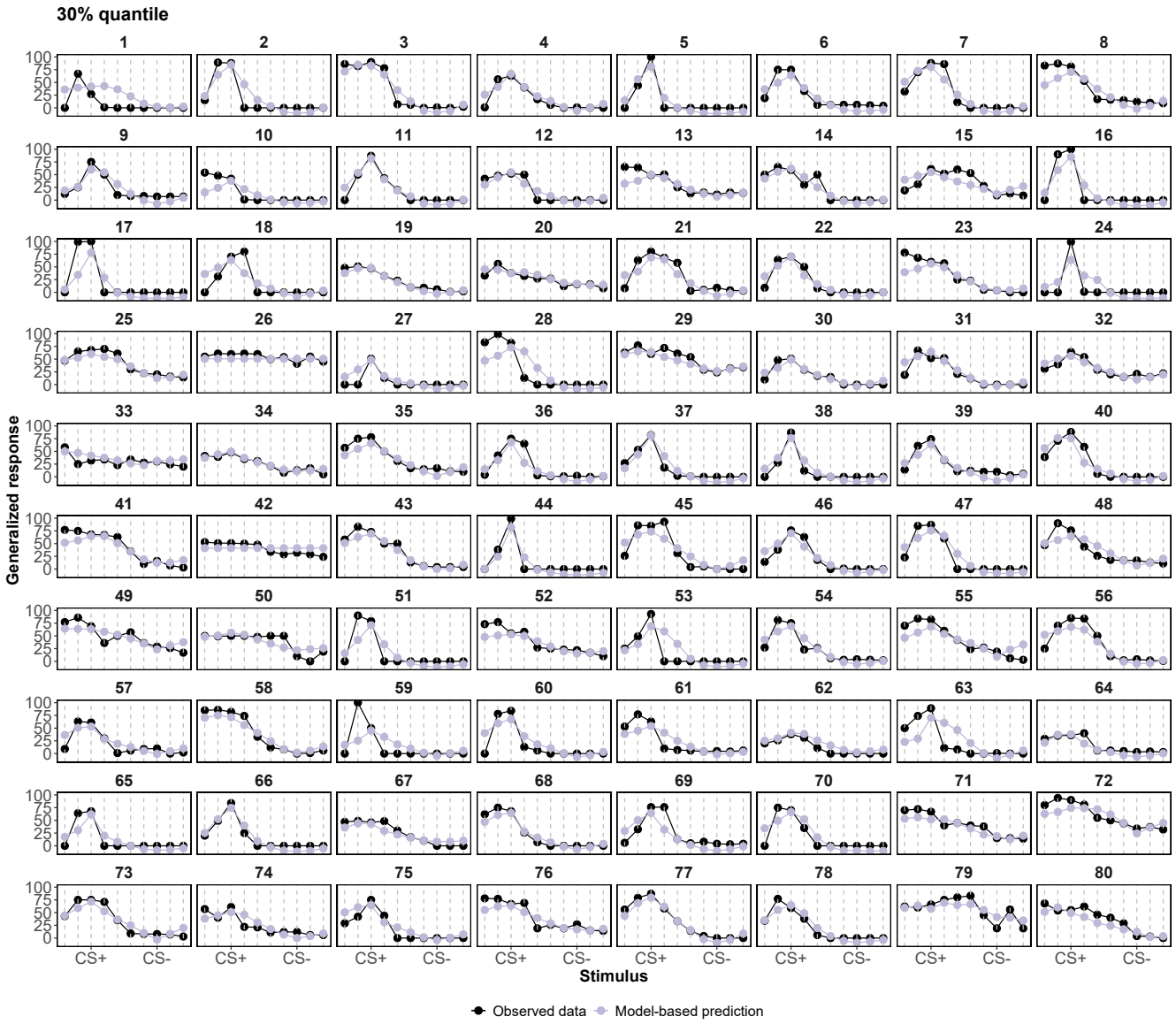
Supplementary Figure 6. Posterior predictive checks for the perceptual model with 90% quantile. The comparison involves evaluating the 90% quantile of 10,000 posterior predictive samples generated by the perceptual computational model against the observed data.



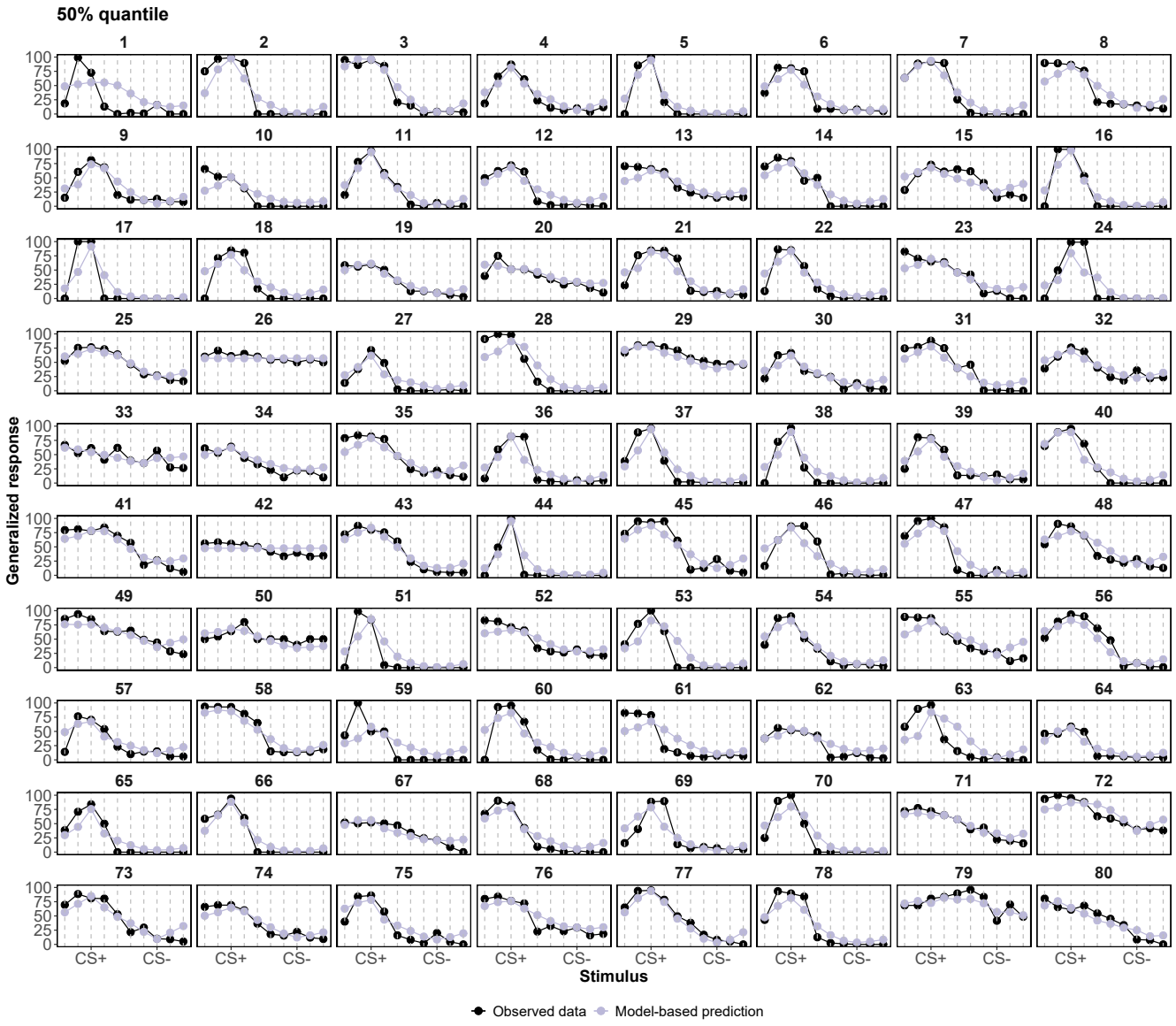
Supplementary Figure 7. Posterior predictive checks for the generalization model with mean. The comparison involves evaluating the mean of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.



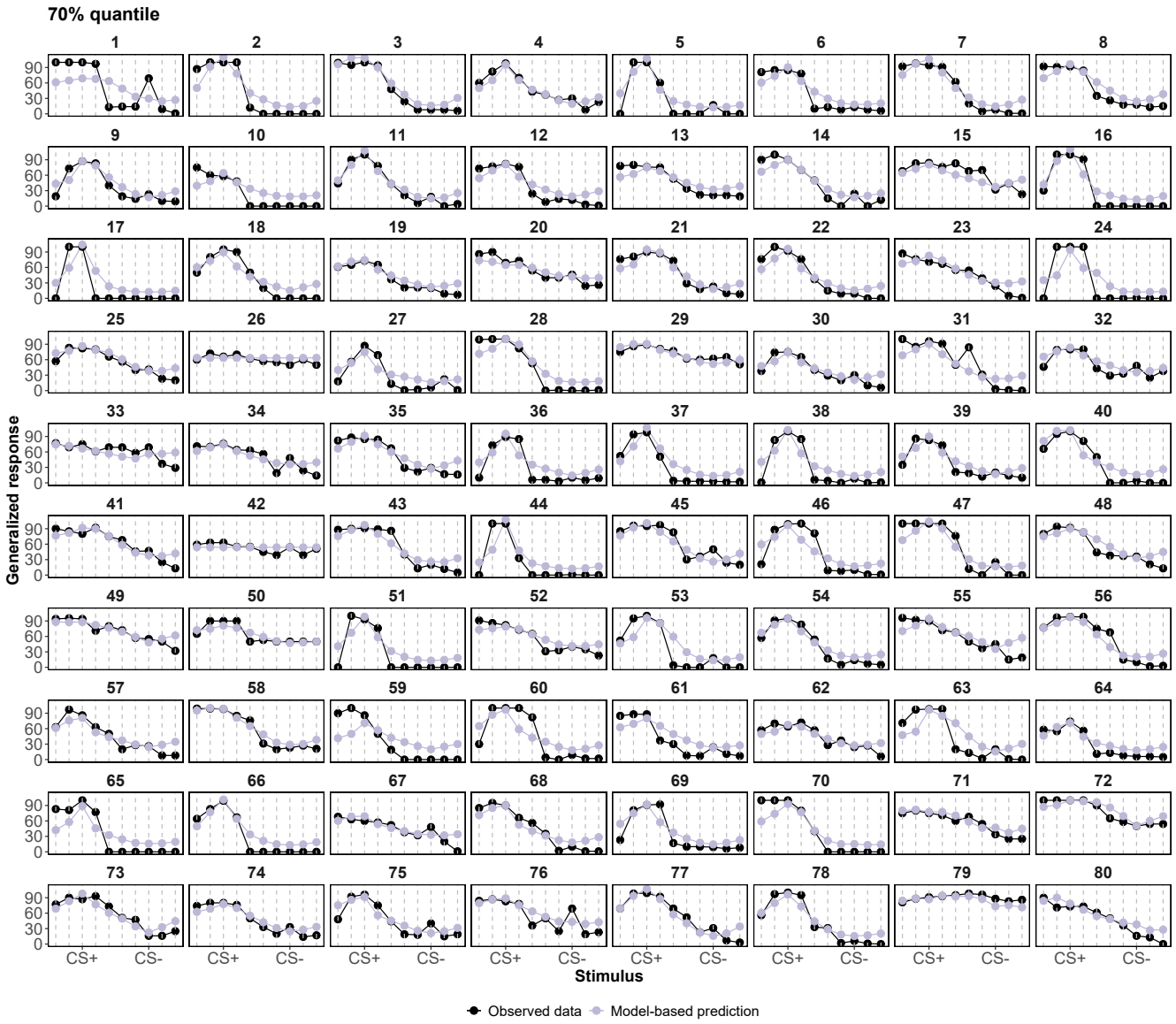
Supplementary Figure 8. Posterior predictive checks for the generalization model with 10% quantile. The comparison involves evaluating the 10% quantile of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.



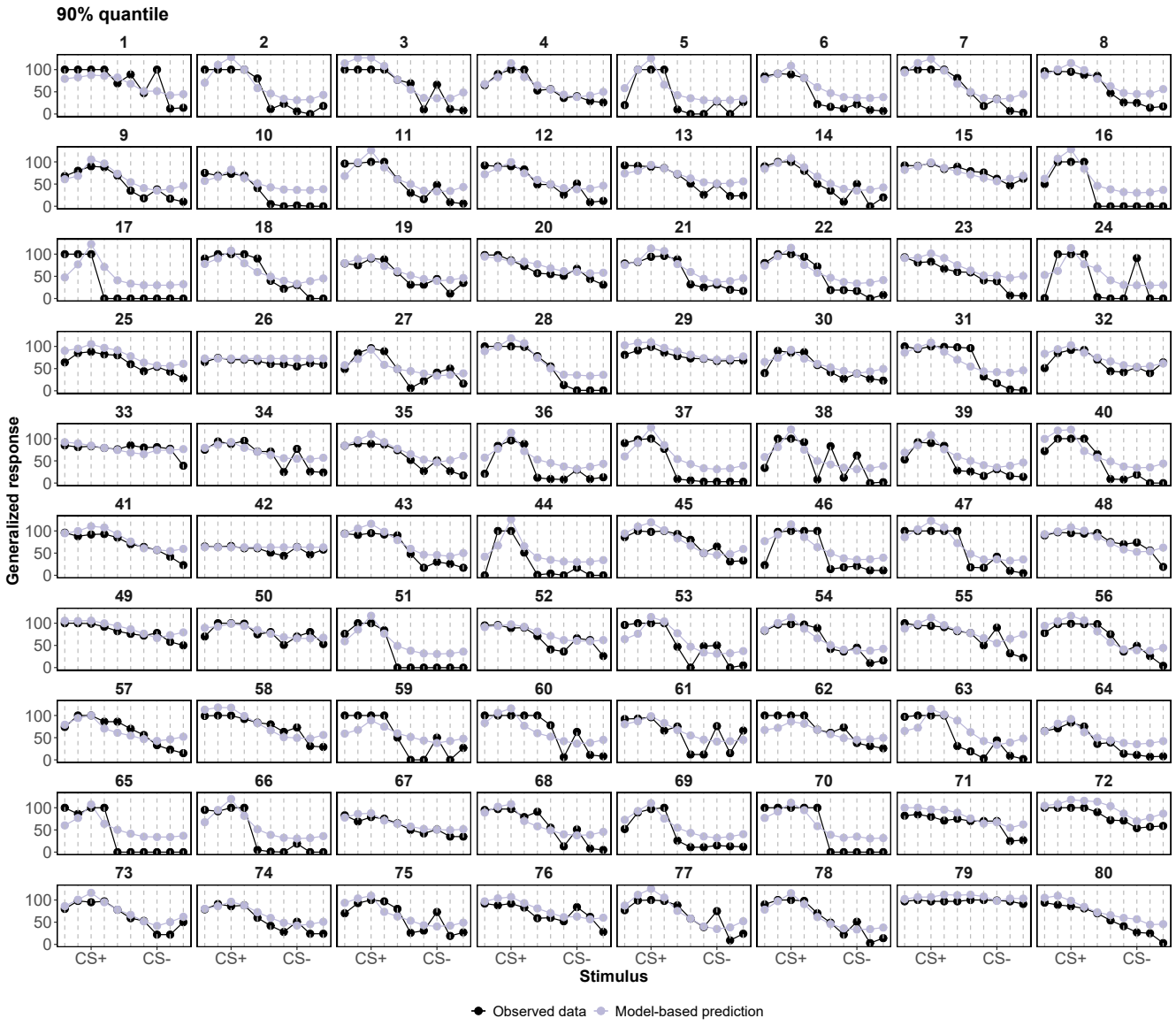
Supplementary Figure 9. Posterior predictive checks for the generalization model with 30% quantile. The comparison involves evaluating the 30% quantile of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.



Supplementary Figure 10. Posterior predictive checks for the generalization model with 50% quantile. The comparison involves evaluating the 50% quantile of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.



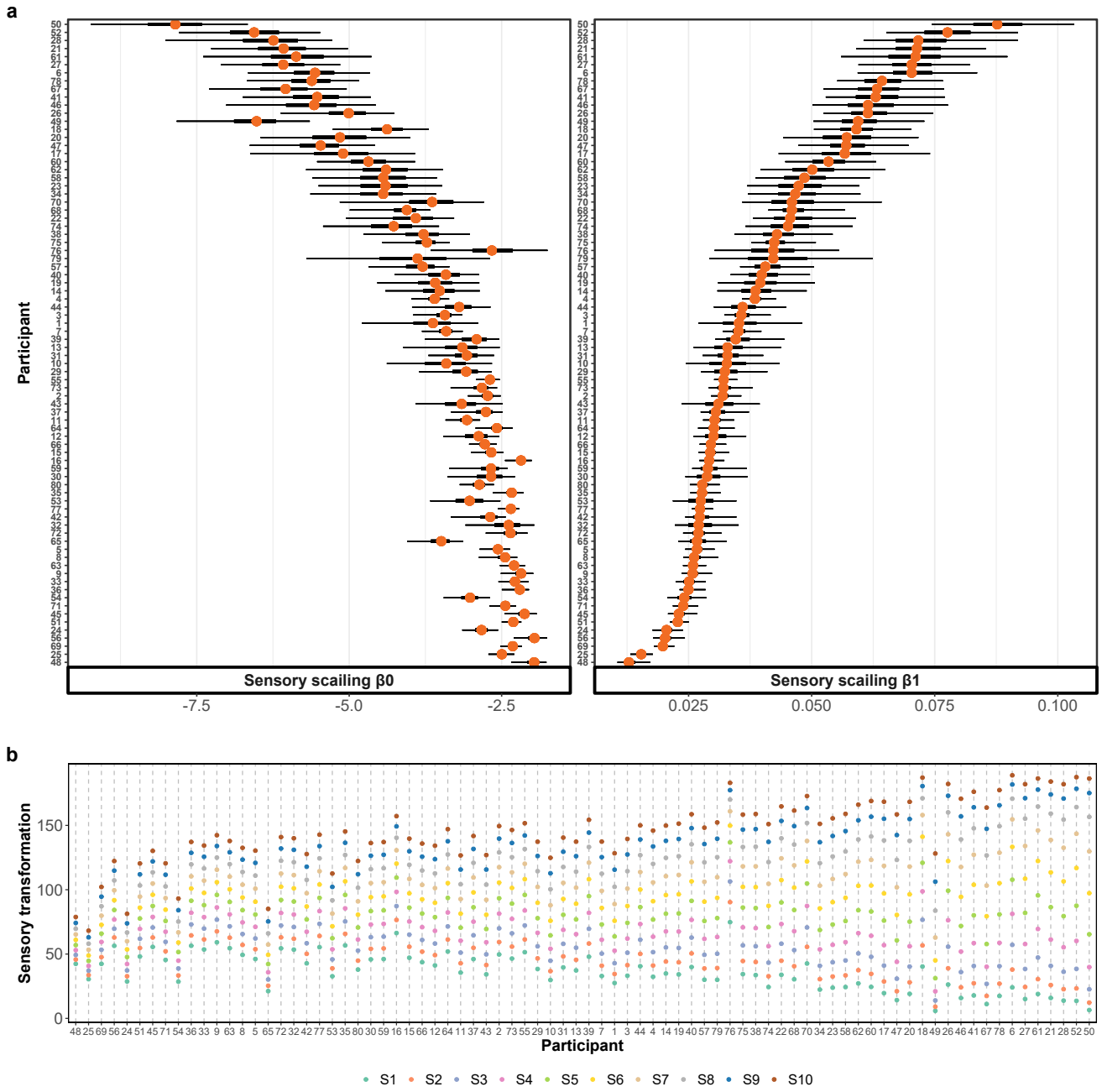
Supplementary Figure 11. Posterior predictive checks for the generalization model with 70% quantile. The comparison involves evaluating the 70% quantile of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.



Supplementary Figure 12. Posterior predictive checks for the generalization model with 90% quantile. The comparison involves evaluating the 90% quantile of 10,000 posterior predictive samples generated by the generalization computational model against the observed data.

Supplementary Note 3

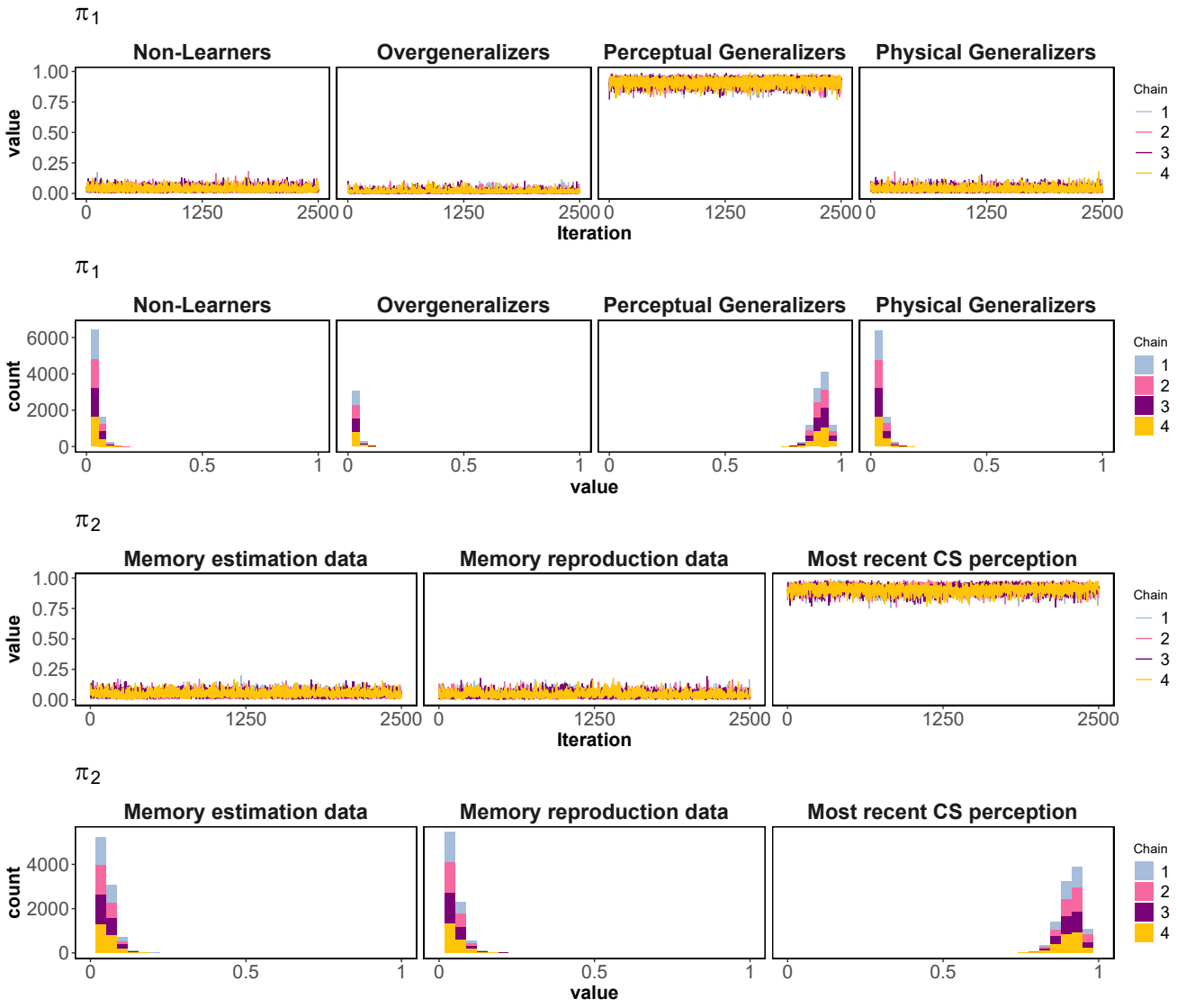
Here, we show the estimated sensory scaling parameters $\beta_{0,i}$ and $\beta_{1,i}$. These two parameters together modulate the shape of the mean of sensory likelihood in the perceptual computational model.



Supplementary Figure 13. Sensory scailing. For each physical stimulus, individual participants demonstrate a distinct mapping from physical to perceptual quantities. Panel a denotes the parameter estimates of β_0 and β_1 (ordered by the 50% quantile of $\beta_{1,i}$)). Panel b illustrates the sensory transformation of each experimental stimulus, calculated with the sensory mapping scaling parameters β_0 and β_1 (50th quantile from the MCMC samples, ordered by the 50% quantile of $\beta_{1,i}$).

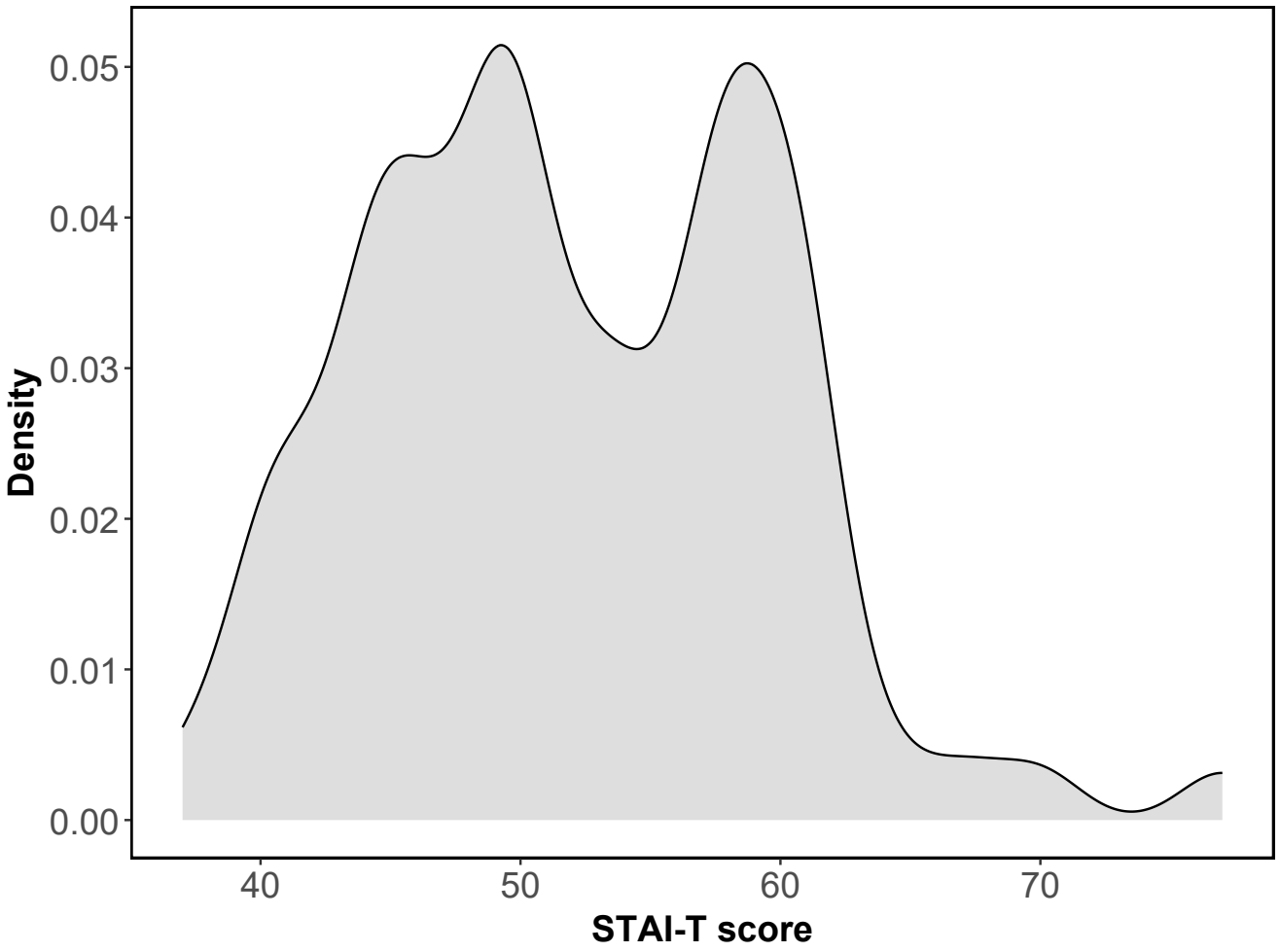
Supplementary Note 4

Here, we present the trace plots and histograms of the MCMC samples of the probability parameters for the latent group allocations in the generalization model.



Supplementary Figure 14. Latent group probabilities. The 4 MCMC chains (2500 samples each) for the probability parameters π_1 and π_2, which correspond to the two mixture components in the generalization model. π_1 denotes the probability of the latent generalization patterns, while π_2 signifies the source of the perceptual memory component in perceptual distance.

Supplementary Note 5



Supplementary Figure 15. STAI-T scores. The distribution of trait anxiety scores