6: Sequential Testing: ROPE vs Bayes Factor vs LOO (Continuous)

Understanding Divergences in Bayesian Decision Making

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1 Part 2: Continuous Predictor Simulation

In this second part, we repeat the sequential testing process for a **continuous predictor** (e.g., word frequency or trial number) to see if decision metrics behave similarly.

1.1 Data Generation (Continuous)

We simulate a log-RT variable with a continuous predictor X (centered, range approx -2 to 2). True Effect of X: 0.05 (approx 5% change per unit of X).

1.2 Simulation Loop (Continuous)

We fit three models again: 1. **Null**: `y ~ 1 + (1|subject) + (1|item)` 2. **Wide**: `y ~ trial_x`, prior `normal(0, 5)` 3. **Narrow**: `y ~ trial_x`, prior `normal(0, 0.2)`

## 1.3 Continuous Results Table

Table 1: Continuous Predictor: Decision Metrics

N	Prior	Estimate_CI	BF10	ROPE_Prob	LOO_Gain
1	Wide	-0.16 [-1.30, 0.73]	1.780000e-01	0.220	-0.387
1	Narrow	-0.01 [-0.16, 0.15]	7.920000e-01	0.508	-0.038
2	Wide	0.03 [-0.34, 0.47]	1.110000e-01	0.352	0.062

| N	Prior	Estimate_CI	BF10	ROPE_Prob	LOO_Gain
2	Narrow	0.02 [-0.13, 0.16]	7.070000e-01	0.557	0.023
3	Wide	0.03 [-0.18, 0.24]	8.600000e-02	0.483	0.361
3	Narrow	0.02 [-0.09, 0.13]	6.280000e-01	0.647	0.190
4	Wide	0.03 [-0.08, 0.14]	6.800000e-02	0.662	-0.235
4	Narrow	0.03 [-0.06, 0.11]	6.170000e-01	0.733	-0.133
5	Wide	0.06 [-0.06, 0.19]	1.460000e-01	0.361	0.053
5	Narrow	0.05 [-0.06, 0.13]	1.023000e+00	0.483	0.150
6	Wide	0.04 [-0.07, 0.16]	6.600000e-02	0.562	0.214
6	Narrow	0.04 [-0.06, 0.12]	6.350000e-01	0.628	0.163
7	Wide	0.05 [-0.04, 0.14]	9.800000e-02	0.524	0.069
7	Narrow	0.04 [-0.04, 0.11]	8.460000e-01	0.602	0.117
8	Wide	0.06 [-0.02, 0.14]	1.680000e-01	0.378	0.205
8	Narrow	0.05 [-0.02, 0.12]	1.338000e+00	0.421	-0.010
9	Wide	0.05 [-0.02, 0.13]	1.420000e-01	0.438	-0.005
9	Narrow	0.05 [-0.02, 0.11]	1.094000e+00	0.507	0.426
10	Wide	0.05 [-0.01, 0.11]	1.410000e-01	0.484	0.001
10	Narrow	0.05 [-0.01, 0.10]	1.450000e+00	0.519	0.014
15	Wide	0.05 [0.01, 0.09]	6.710000e-01	0.462	0.513
15	Narrow	0.05 [0.01, 0.09]	5.445000e+00	0.498	-0.100
20	Wide	0.06 [0.03, 0.09]	7.014000e+00	0.192	0.833
20	Narrow	0.06 [0.03, 0.09]	5.400300e+01	0.239	0.548
25	Wide	0.06 [0.03, 0.09]	3.674800e+01	0.221	0.379
25	Narrow	0.06 [0.03, 0.09]	1.050360e+02	0.277	0.513
30	Wide	0.07 [0.04, 0.10]	4.132826e+05	0.046	0.786
30	Narrow	0.07 [0.04, 0.09]	5.481336e+17	0.060	1.036
40	Wide	0.07 [0.05, 0.09]	1.375817e+15	0.020	2.498
40	Narrow	0.07 [0.05, 0.09]	Inf	0.026	2.218
50	Wide	0.07 [0.06, 0.09]	1.465803e+15	0.000	3.197
50	Narrow	0.07 [0.06, 0.09]	Inf	0.000	3.473
100	Wide	0.08 [0.07, 0.09]	3.552615e+14	0.000	10.803
100	Narrow	0.08 [0.07, 0.09]	1.330036e+15	0.000	11.100

1.4 Visualization (Continuous)

Estimates (Slope)

Bayes Factor (Slope != 0)

ROPE Prob (Slope ~ 0)

LOO Gain
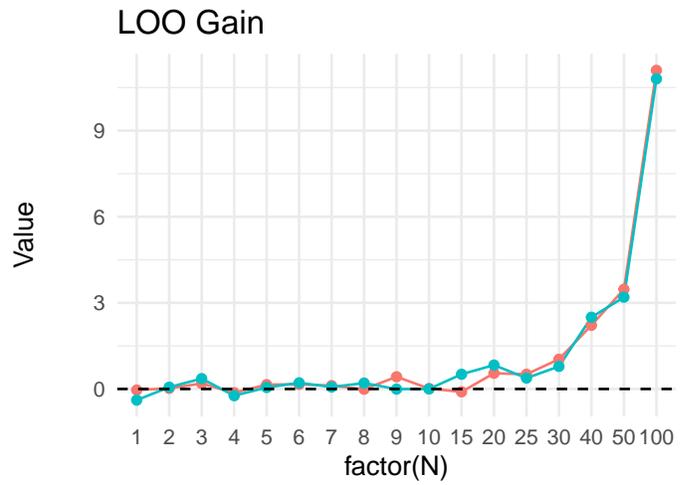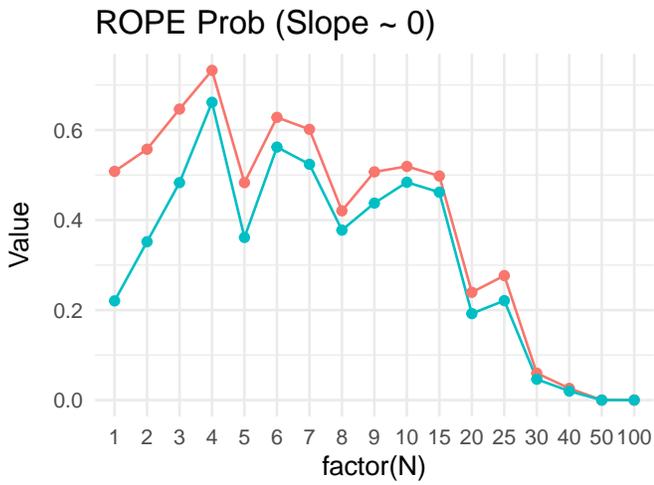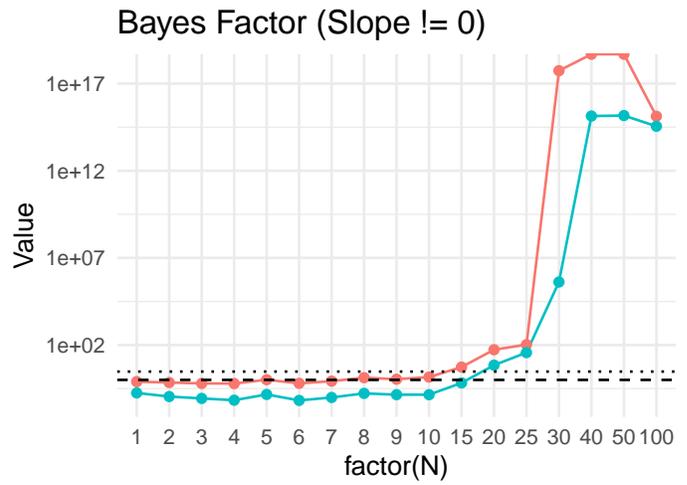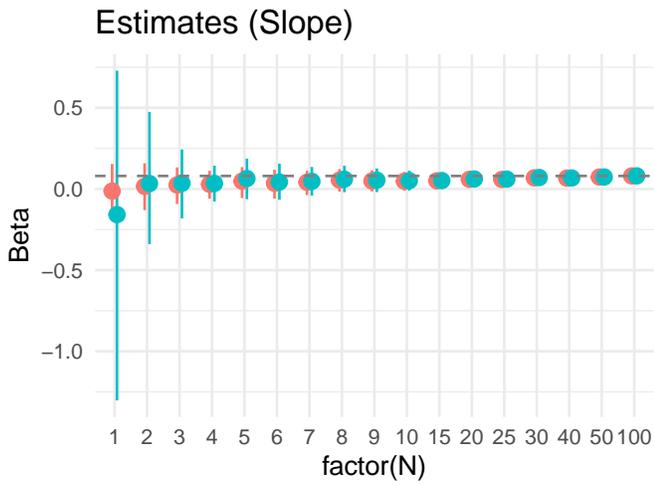
1.5 Visualization (Zoomed: N >= 10)
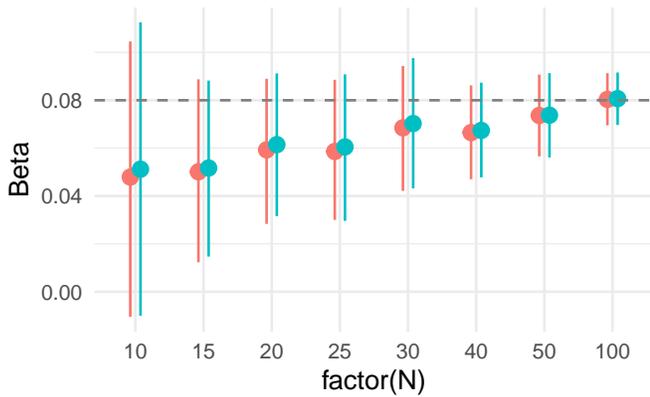
Checking convergence by ignoring small N chaos.
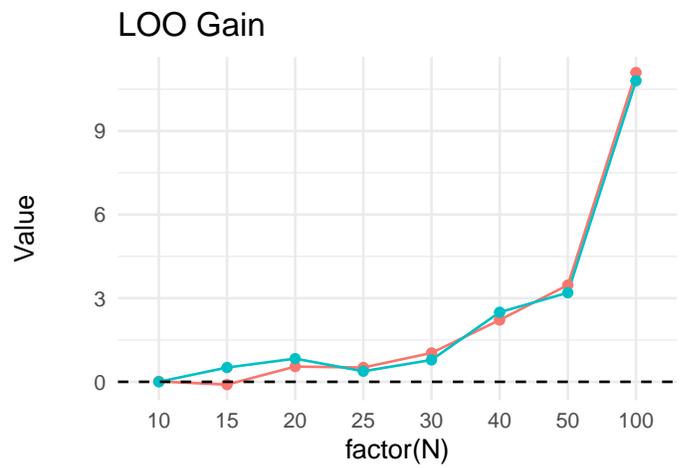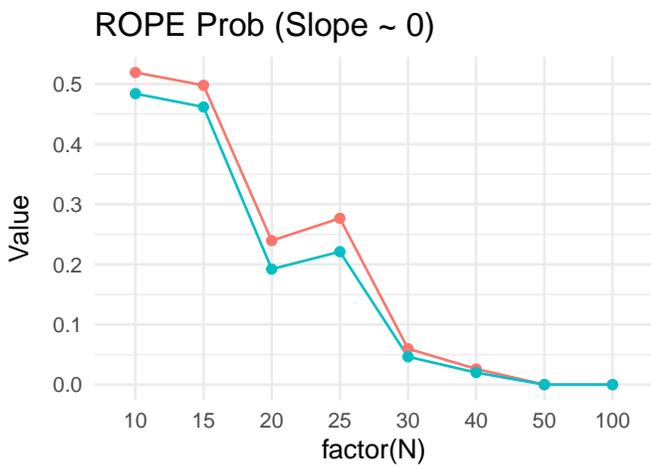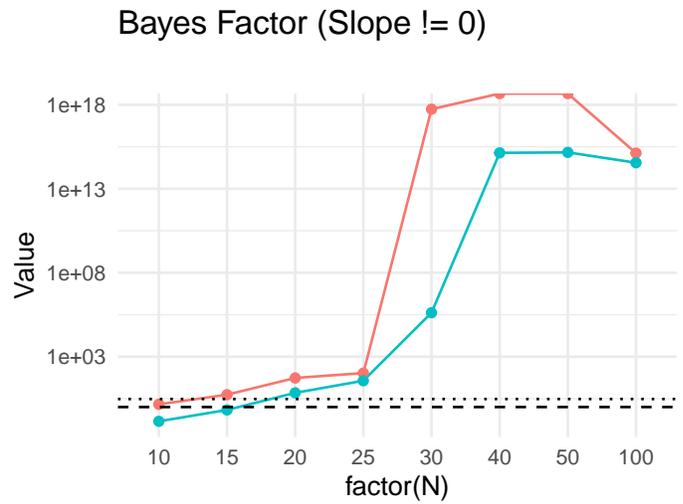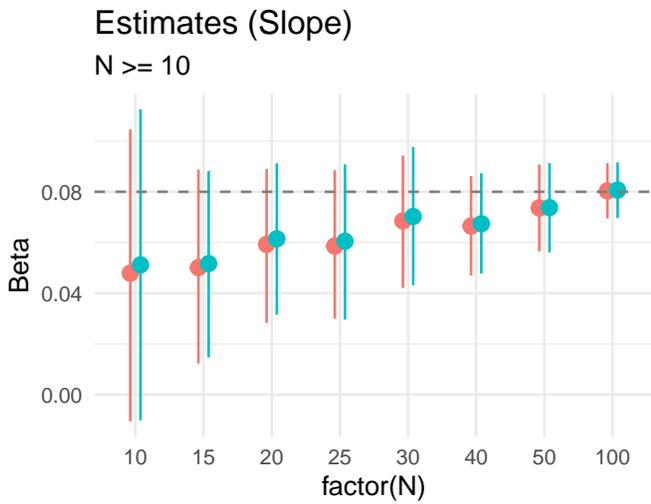
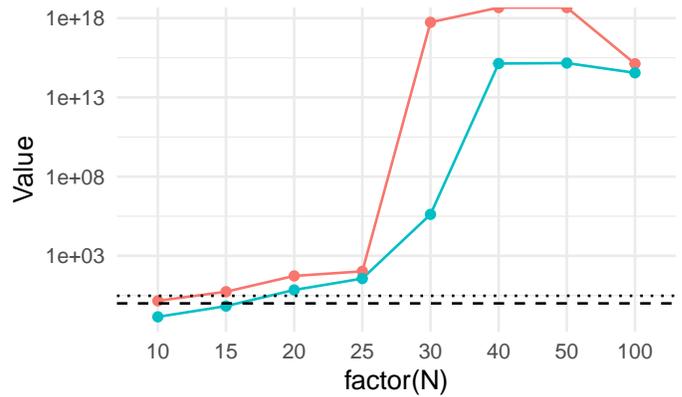## 1.6 Visualization (Uncertainty: N >= 10)

Including LOO uncertainty (SE_{diff}).
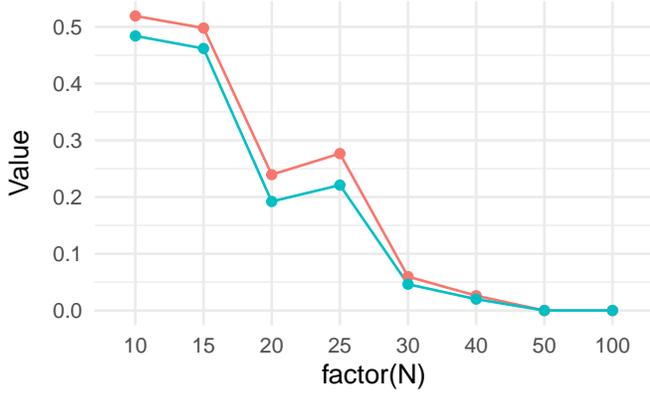
Estimates (Slope)
N >= 10

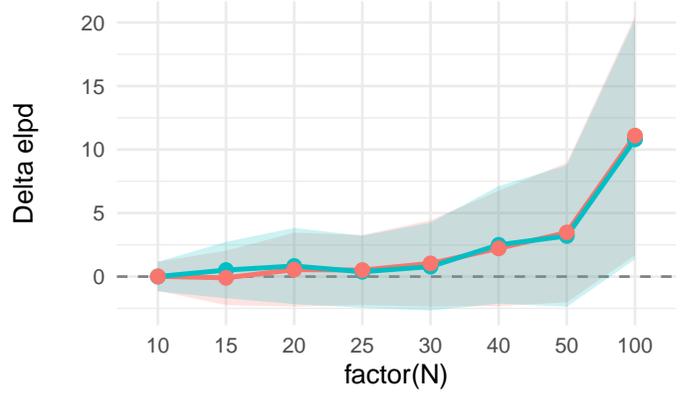## Bayes Factor (Slope != 0)

ROPE Prob (Slope ~ 0)

Predictive Gain (LOO)
Mean +/− 2 SE

Prior ● Narrow ● Wide   Prior — Narrow — Wide   Prior ▬ Narrow ▬ Wide

1.7 Simulation Results Visualization

False Positives (Low Noise)

Power (Low Noise)

False Positives (High Noise)

Power (High Noise)

Method ● BIC BF > 10 ● brms BF > 10 ● P−Value < .05
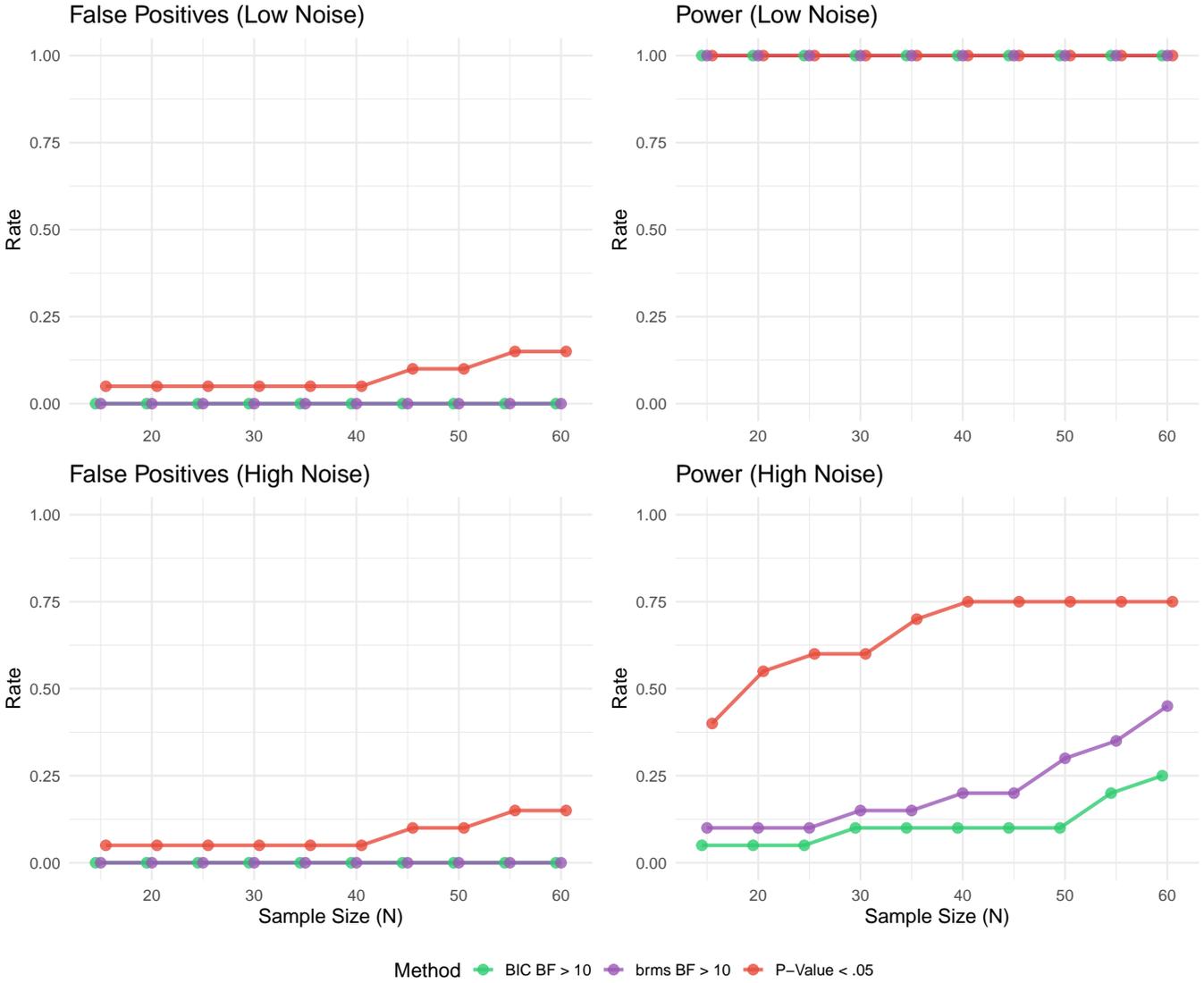
1.8 Simulation Results Table

Table 2: Sequential Testing Results: Continuous Predictor Simulation

Noise	Scenario	check_n	P-Value (<.05)	Bayes Factor (BIC) > 10	Bayes Factor (brms) > 10
High Noise (SD=0.8)	H0 (No Effect)	15	5.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	20	5.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	25	5.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	30	5.0%	0.0%	0.0%

Noise	Scenario	check_n	P-Value (<.05)	Bayes Factor (BIC) > 10	Bayes Factor (brms) > 10
High Noise (SD=0.8)	H0 (No Effect)	35	5.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	40	5.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	45	10.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	50	10.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	55	15.0%	0.0%	0.0%
High Noise (SD=0.8)	H0 (No Effect)	60	15.0%	0.0%	0.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	15	40.0%	5.0%	10.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	20	55.0%	5.0%	10.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	25	60.0%	5.0%	10.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	30	60.0%	10.0%	15.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	35	70.0%	10.0%	15.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	40	75.0%	10.0%	20.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	45	75.0%	10.0%	20.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	50	75.0%	10.0%	30.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	55	75.0%	20.0%	35.0%
High Noise (SD=0.8)	H1 (Effect=0.05)	60	75.0%	25.0%	45.0%
Low Noise (SD=0.2)	H0 (No Effect)	15	5.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	20	5.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	25	5.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	30	5.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	35	5.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	40	5.0%	0.0%	0.0%

Noise	Scenario	check_n	P-Value (<.05)	Bayes Factor (BIC) > 10	Bayes Factor (brms) > 10
Low Noise (SD=0.2)	H0 (No Effect)	45	10.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	50	10.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	55	15.0%	0.0%	0.0%
Low Noise (SD=0.2)	H0 (No Effect)	60	15.0%	0.0%	0.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	15	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	20	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	25	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	30	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	35	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	40	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	45	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	50	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	55	100.0%	100.0%	100.0%
Low Noise (SD=0.2)	H1 (Effect=0.05)	60	100.0%	100.0%	100.0%