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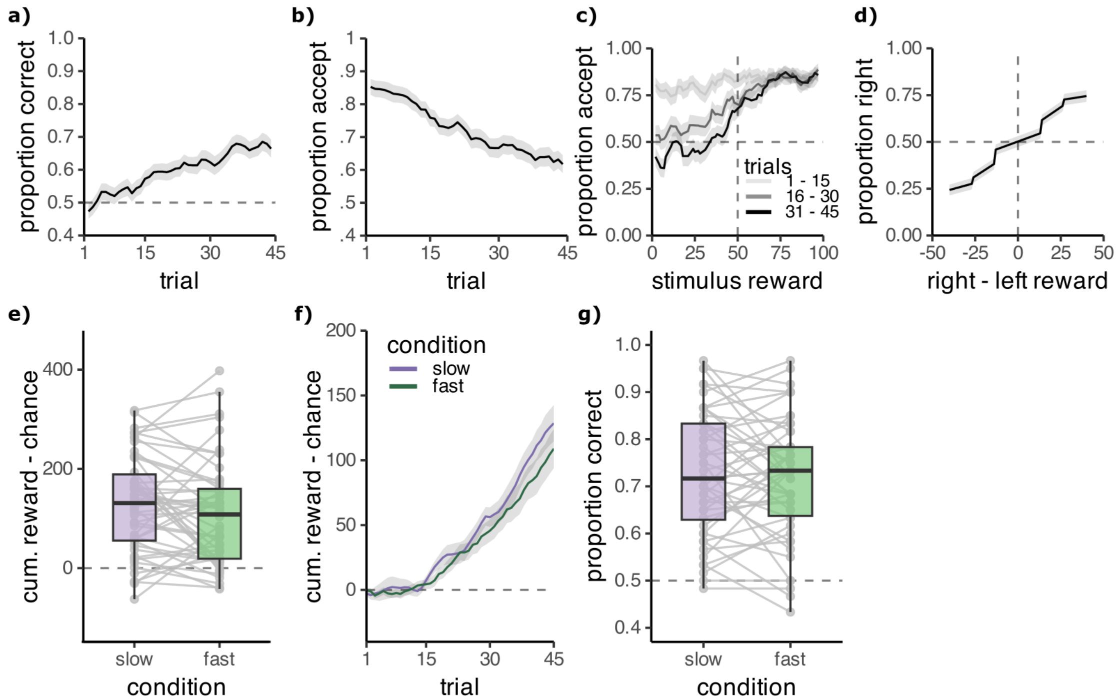

Figure S1: **Participant behaviour in the pilot experiment. a)** Accuracy increased from 51% in the first ten trials to 67% in the last ten trials of the learning phase ($t(49) = 8.35$, $p < .001$, $d = 1.18$). Note that here the learning phase was capped at 45 trials, explaining the lower accuracy compared to the main experiment. **b)** We also found a decrease in exploratory 'accept' choices throughout learning, from around 84% to 64% ($t(49) = -9.688$, $p < .001$, $d = 1.394$). **c)** Similar to the main experiment, participants start selectively rejecting low value stimuli in the learning phase. **d)** Participants were able to correctly identify higher value stimuli from previously unseen stimuli in the test phase (mean accuracy 71% significantly higher than chance $t(49) = 12.26$, $p < .001$, $d = 5.79$). **e)** Participants accumulated marginally more reward in slow than in fast blocks in the learning phase ($t(49) = 1.57$, $p_{1-sided} = .061$, $d = 0.22$). **f)** Participants increase in cumulative reward in the learning phase was numerically higher in slow than in fast blocks ($\beta = 25.16$, 95% CI = [-6.52 to 56.83], $X^2(1) = 2.37$, $p = .124$). **g)** We did not find a difference in test phase accuracy between slow and fast blocks. Grey points and lines indicate individual participants ($t(49) = 1.14$ $p_{1-sided} = .130$, $d = 0.16$).

S1 Preregistration description

The main behavioural predictions and analyses followed a preregistered plan submitted prior to data collection (see https://osf.io/6dy8f and S1 Table below). ANOVAs were replaced with mixed effects models as these have been shown to better take into account individual differences between participants [73, 75, 76]. Two analyses were added to investigate the main effects in more detail, see S1 Table.

While the task and conditions are identical between the pre-registration and the paper (learning phase and test phase, bi-dimensional stimuli with slow/fast and relevant/irrelevant feature), the design in the pre-registration differs in three key ways: (a) multiple levels of slow feature variability, (b) fast feature variability determined by a Gaussian random walk instead of random sampling, and (c) the parameters of the colour space used. We based these changes on pilot data included in the data repository, but not analysed here.

The pre-registration lists mean accuracy below 65% as an exclusion criterion, however during data collection it became clear that this criterion was too stringent, as it would entail excluding 20 participants in the main experiment and 33 participants in the pilot experiment. Therefore, this criterion was not applied, instead, no participants were excluded. The main results remained unchanged when applying this exclusion criterion. In the main experiment, the comparison of learning phase cumulative reward was marginal ($M_S = 351.85 \pm 15.53$, $M_F = 319.13 \pm 19.35$, $t(29) = 1.69$, $p_{1-sided} = .051$, $d = 0.31$), however the effect in test phase accuracy was stronger than with the full sample ($M_S = 83\% \pm 1$, $M_F = 80\% \pm 1$, $t(29) = 2.08$, $p_{1-sided} = .023$, $d = 0.38$). In the pilot experiment, we did not find evidence for the effect, however note that after exclusion N=17 (learning phase cumulative reward: $M_S = 224.43 \pm 15.57$, $M_F = 214.49 \pm 21.30$, $t(16) = 0.53$, $p_{1-sided} = .302$, $d = 0.13$; test phase accuracy ($M_S = 85\% \pm 2$, $M_F = 82\% \pm 2$, $t(16) = 1.14$, $p_{1-sided} = .135$, $d = 0.28$).

Main Analyses	PR	Paper	Comment
One-sided paired t-test comparing learning phase reward in slow vs fast blocks	yes	yes	
One-sided paired t-test comparing learning phase accuracy in slow vs fast blocks	yes	yes	
One-sided paired t-test comparing test phase accuracy in slow vs fast blocks	yes	yes	
Additional Analyses	**PR**	**Paper**	**Comment**
Two-way repeated measures ANOVA: effect of within-subject factor condition (slow vs. fast) and within-subject factor time (early vs. late half of the block) on learning phase reward	yes	S2a Fig	replaced with: Linear mixed effects model with trial number, condition (slow/fast), and trial×condition interaction as predictors, predicting learning phase trial-wise cumulative reward
Two-way repeated measures ANOVA: effect of within-subject factor condition (slow vs. fast) and within-subject factor time (early vs. late half of the block) on learning phase accuracy	yes	S2b Fig	replaced with: logistic mixed effects model with trial number, stimulus value, condition (slow/fast) and trial×value as predictors, predicting learning phase choice accuracy
Linear mixed effects model with the absolute value difference between the shown stimuli and condition (slow vs. fast) as predictors, predicting choice accuracy in the test phase	no	yes	
Linear mixed effects model with relevant and irrelevant feature angles as (circular) predictors, predicting learning phase choices	no	yes	
Two-way repeated measures ANOVA: effect of within-subject factor condition (slow vs. fast) and within-subject factor relevant feature (colour vs. shape) on learning phase reward/accuracy and test phase accuracy	yes	S2d-f Fig	
Pearson correlation between learning phase accuracy or reward and test phase accuracy	yes	S2c Fig	
Two-way mixed model ANOVA: effect of within-subject factor condition (slow vs. fast) and between-subject factor slow speed (random walk sd 30,45 or 60) on learning phase reward/accuracy and test phase accuracy	yes	no	The experiment design no longer included different levels for the slow speed.

Table S1: **Overview of analyses in the pre-registration (PR) and the paper.**

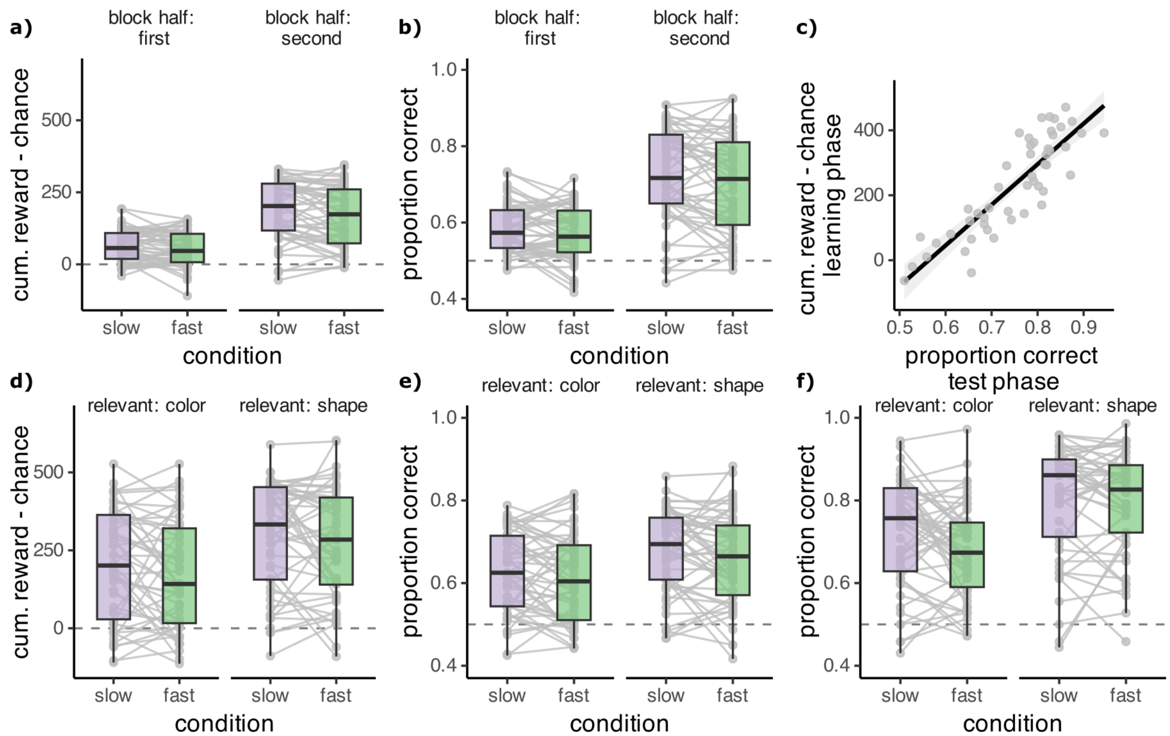

Figure S2: **Effect of additional parameters on the slowness prior effect. a)** We compared the behavioural effect of feature speed on accumulated reward in the first and second half of each learning phase. We did not find a significant interaction between feature speed and block half ($F(1, 49) = 0.48$, $p > .05$). We did find significant main effects of feature speed ($F(1, 49) = 4.70$, $p = .035$) and block half ($F(1, 49) = 191$, $p < .001$). **b)** We found equivalent results using learning phase accuracy as our dependent measure (interaction: $F(1, 49) = 0.32$, $p = 0.574$, feature speed: $F(1, 49) = 3.90$, $p = 0.054$, block half: $F(1, 49) = 177$, $p < .001$). **c)** There was a large correlation between accumulated reward in the learning phase and accuracy in the test phase ($r = .86$, $p < .001$). **d)** We examined the effect of feature type (colour/shape) on the effect of feature speed. We did not find a significant interaction between feature speed and feature identity on accumulated reward in the learning phase ($F(1, 49) = 0.019$, $p > .05$), though the main effects of feature speed ($F(1, 49) = 4.70$, $p = 0.035$) and feature identity were significant ($F(1, 49) = 23.22$, $p < .001$). **e)** Results were similar when using learning phase accuracy as the dependent measure (interaction: $F(1, 49) = 0.09$, $p = 0.764$, speed: $F(1, 49) = 3.89$, $p = 0.054$, type: $F(1, 49) = 17.5$, $p < .001$). **f)** We found a significant interaction between feature speed and feature identity in the test phase accuracy ($F(1, 49) = 4.614$, $p = 0.0367$). Participants were significantly more accurate on slow compared to fast blocks when colour was the relevant feature ($p = 0.014$), but not when the shape was the relevant feature (0.451). The main effect of feature speed ($F(1, 49) = 3.417$, $p = 0.071$) was marginal, while the main effect of feature identity ($F(1, 49) = 39.05$, $p < 0.001$) was significant. Grey points and lines are individual participants. All data is from the main experiment.

S2 Effect sizes and confidence intervals for the mixed effects models

The following tables report the parameter estimates for the mixed effect models. CI_l and CI_u denote the lower and upper bound of the 95% confidence interval, respectively. The standard deviation of the random effects is reported under σ_{rand}. Not all fixed effects are included as random effects. For all models, random effects are per subject.

Parameter	Estimate	CI_l	CI_u	σ_{rand}
(Intercept)	-124.03	-146.25	-101.81	75.41
condition [slow]	-17.17	-36.90	2.57	59.92
trial	254.27	203.32	305.22	180.64
condition $\times$ trial	39.07	2.44	75.70	123.05
Residual				114.76

Table S2: **Best model predicting predicting cumulative reward in the learning phase.**

Parameter	Estimate	CI_l	CI_u	σ_{rand}
(Intercept)	-0.63	-0.79	-0.48	0.41
condition [slow]	0.08	-0.00	0.16	0.21
$\lvert R_t - 50\rvert$	-0.23	-0.33	-0.13	
trial	1.60	1.48	1.73	
$\lvert R_t - 50\rvert \times$ trial	0.53	0.41	0.66	

Table S3: **Best model predicting correct choices in the learning phase.**

Parameter	Estimate	CI_l	CI_u	χ^2	Df	Pr(>Chisq)	σ_{rand}
(Intercept)	3.18	2.92	3.45				0.59
$cos(\theta_R)$	-1.00	-1.39	-0.62	110.98	1	$< .001$	0.85
$sin(\theta_R)$	-0.07	-0.36	0.23	0.14	1	0.7116	
$cos(\theta_I)$	-0.04	-0.34	0.26	2.75	1	0.0970	0.18
$sin(\theta_I)$	0.02	-0.28	0.31	0.24	1	0.6220	
trial	-2.63	-2.89	-2.38	423.41	1	$< .001$	
$cos(\theta_R)$ $\times$trial	2.97	2.60	3.34	247.04	1	$< .001$	
$sin(\theta_R)$ $\times$trial	0.07	-0.28	0.43	0.15	1	0.6943	
$cos(\theta_I)$ $\times$trial	-0.04	-0.40	0.32	0.04	1	0.8407	
$sin(\theta_I)$ $\times$trial	-0.00	-0.36	0.36	0.00	1	0.9860	

Table S4: **Mixed effects model predicting participant learning phase choices from the feature positions in the slow blocks.** The statistical tests reported are Type-II Wald χ^2 tests.

Parameter	Estimate	CI_l	CI_u	χ^2	Df	Pr(>Chisq)	σ_{rand}
(Intercept)	3.02	2.75	3.29				0.63
$cos(\theta_R)$	-1.28	-1.65	-0.92	96.04	1	$< .001$	0.81
$sin(\theta_R)$	-0.21	-0.50	0.08	0.22	1	0.6367	
$cos(\theta_I)$	-0.18	-0.47	0.12	7.07	1	0.0078	0.12
$sin(\theta_I)$	-0.12	-0.41	0.17	0.00	1	0.9629	
trial	-2.37	-2.62	-2.12	306.90	1	$< .001$	
$cos(\theta_R)$ ×trial	3.13	2.78	3.49	297.79	1	$< .001$	
$sin(\theta_R)$ ×trial	0.24	-0.11	0.59	1.87	1	0.1712	
$cos(\theta_I)$ ×trial	0.09	-0.26	0.44	0.26	1	0.6095	
$sin(\theta_I)$ ×trial	0.15	-0.21	0.50	0.66	1	0.4166	

Table S5: **Mixed effects model predicting participant learning phase choices from the feature positions in the fast blocks.** The statistical tests reported are Type-II Wald χ^2 tests.

Parameter	Estimate	CI_l	CI_u	σ_{rand}
(Intercept)	1.16	0.99	1.33	0.57
condition [slow]	0.14	0.01	0.28	0.40
$\lvert R_{\mathrm{diff},t} \rvert$	0.46	0.42	0.51	

Table S6: **Best model predicting correct choices in the test phase.**

Parameter	Estimate	CI_l	CI_u	σ_{rand}
(Intercept)	0.06	-0.02	0.13	0.20
condition [slow]	-0.04	-0.12	0.04	0.10
$R_{\mathrm{diff},t}$	1.19	1.13	1.25	
condition [slow] $\times R_{\mathrm{diff},t}$	0.13	0.04	0.21	

Table S7: **Best model predicting choices from the reward difference in the test phase.**

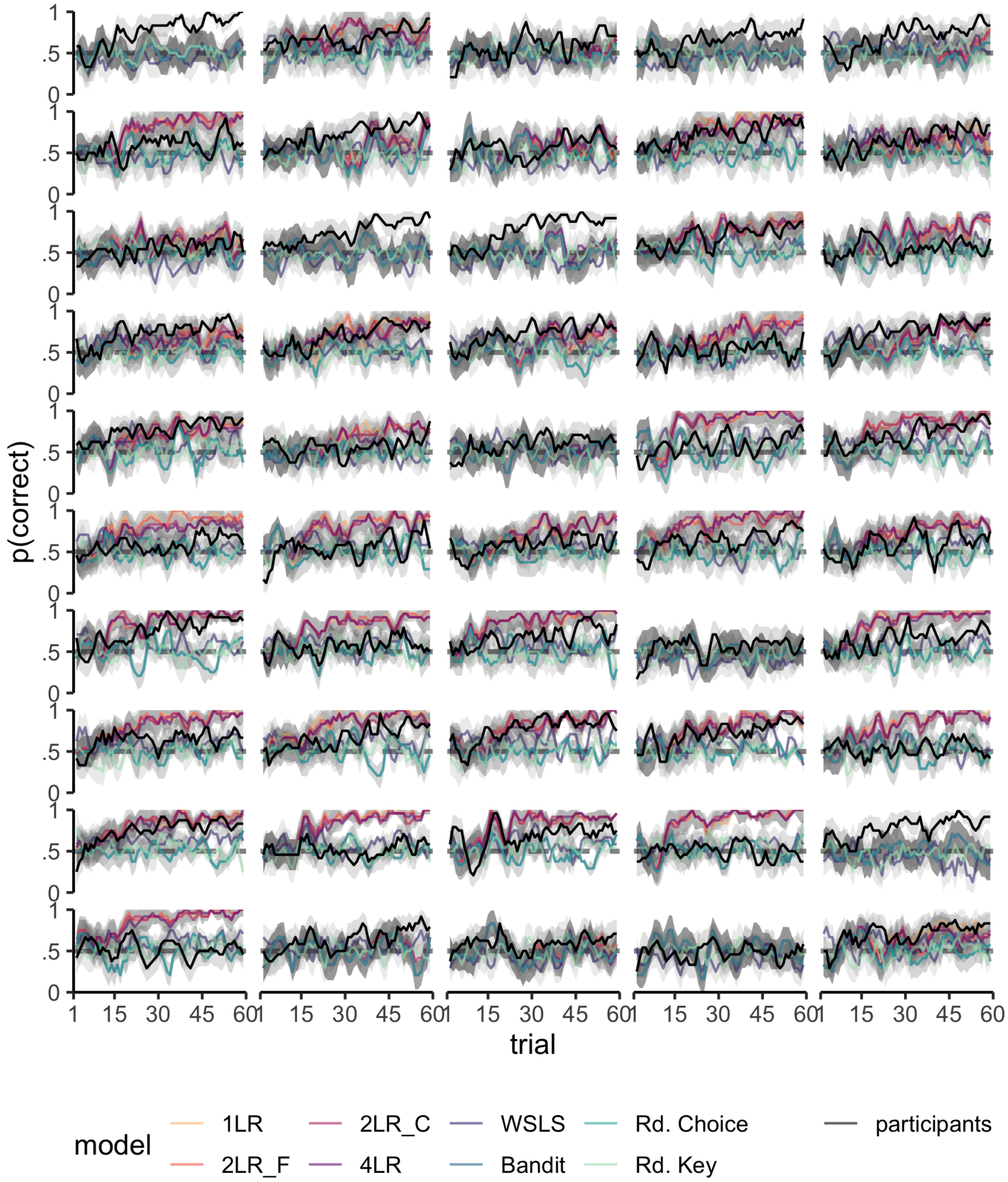

Figure S3: **Models fit individual participant learning curves.** Participant learning curves overlaid with the model learning curves, simulated using the parameter values obtained from maximum likelihood fitting.

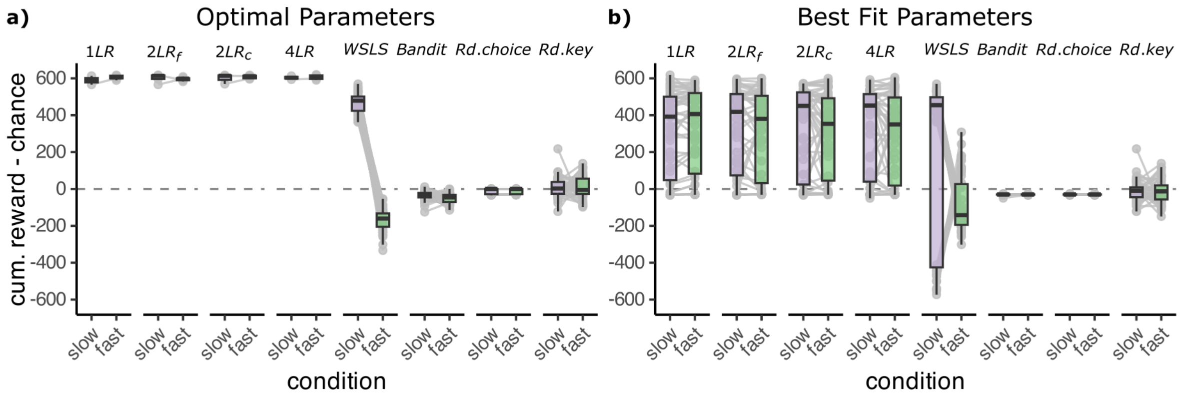

Figure S4: **Model performance in the slow and fast condition.** Cumulative reward relative to chance level obtained in the learning phase by the models using **a)** reward maximising parameters and **b)** maximum likelihood parameters.

S3 Development of learning rates

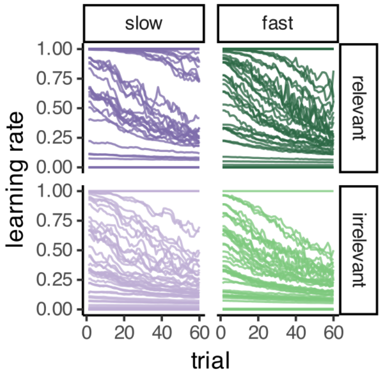

Figure S5: **Development of the learning rates of the four learning rate model.** Plots show the development of the learning rates across the trials of the learning phase. The learning rates on the first trial were obtained through maximum likelihood fitting. With decreasing uncertainty about the stimulus values, the learning rates decreased. The learning rates could not increase. Each line is an individual participant, averaged across blocks.

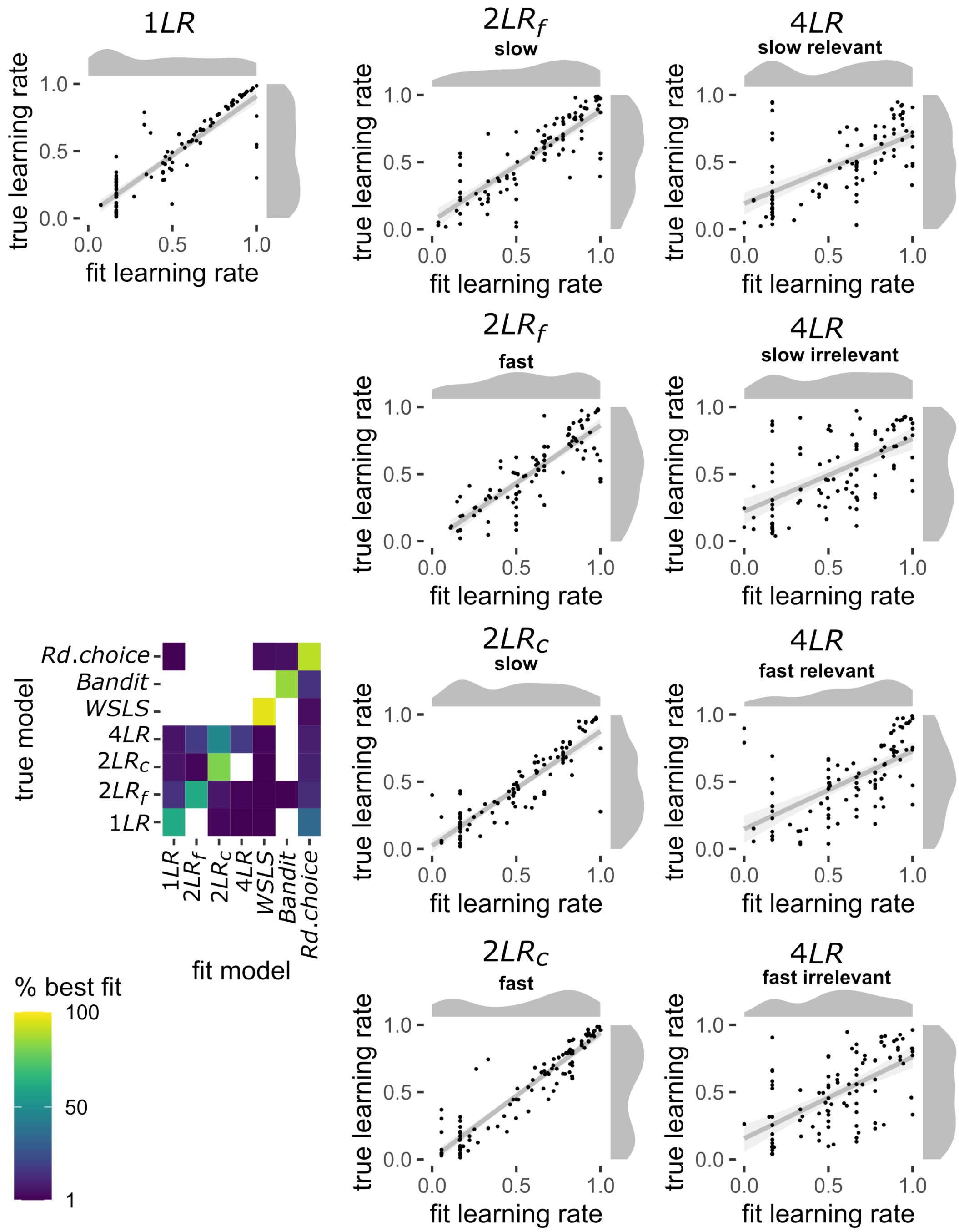

Figure S6: **Parameter and model recovery.** Model fitting and comparison was performed as described in the Methods. 100 data-sets were simulated for each model using random parameter values. Dot plots show the relationship between the true learning rate and the learning rate obtained through maximum likelihood fitting. Distributions of both are shown in grey. Points are individual simulations. The matrix shows model recovery. True models are accurately identified in most simulations. The 4LR model is sometimes misidentified as the $2LR_c$ and to a lesser extent the $2LR_f$ model. This likely is because the 4LR model is a specialised case of these two models. If the four learning rates of the 4LR model are similar to each other, this model behaves similarly to the two-learning (2LR) rate models.