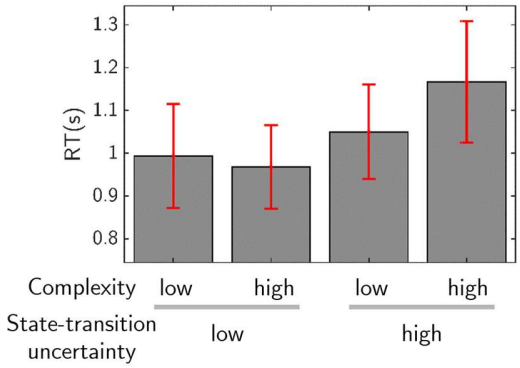
Appendix. Additional behavioral analyses

Here we provide results of additional behavioral analyses to fully quantify behavior.

1. Effects of complexity and uncertainty on choice reaction times

We found an interaction effect of the experimental conditions on reaction time (p=0.032).



Tests of Within-Subjects Contrasts

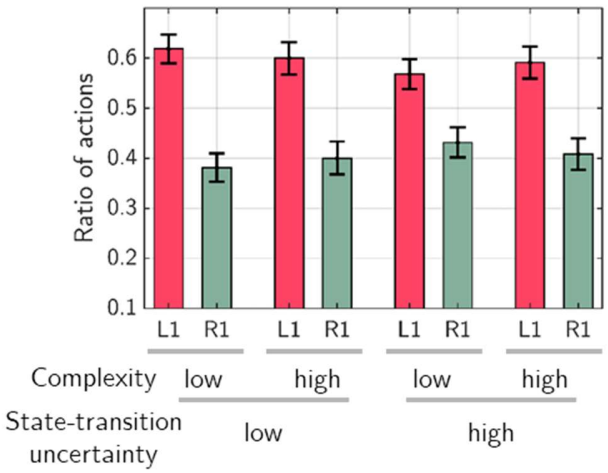
Measure: MEASURE_1

Source	uncertainty	complexity	Type III Sum of Squares	df	Mean Square	F	Sig.
uncertainty	Linear		.390	1	.390	12.420	.002
Error(uncertainty)	Linear		.723	23	.031		
complexity		Linear	.049	1	.049	1.663	.210
Error(complexity)		Linear	.683	23	.030		
uncertainty * complexity	Linear	Linear	.123	1	.123	5.219	.032
Error (uncertainty*complexity)	Linear	Linear	.541	23	.024		

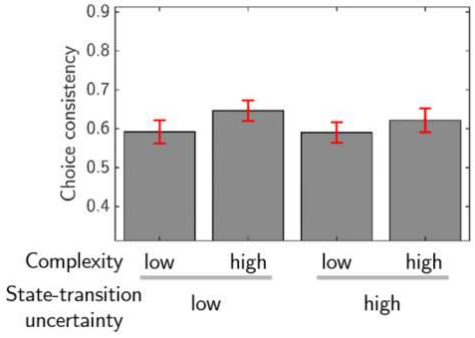
2. Choice behavior at each stage

(1) stage 1

- choice bias: There is a left choice bias because in the left branch, all the main choices (L1,R1) are associated with coins, whereas in the right branch, only one main choice (R1) is associated with a coin. This indicates that subjects made choices based on value learning.



- choice consistency: We found a main effect of complexity on choice consistency.



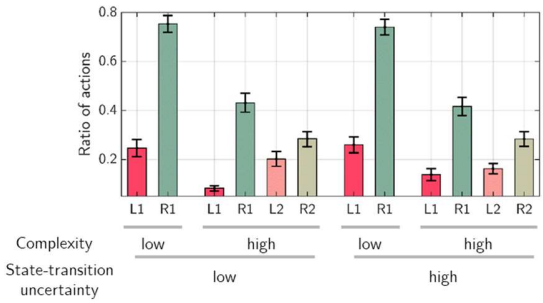
Tests of Within-Subjects Contrasts

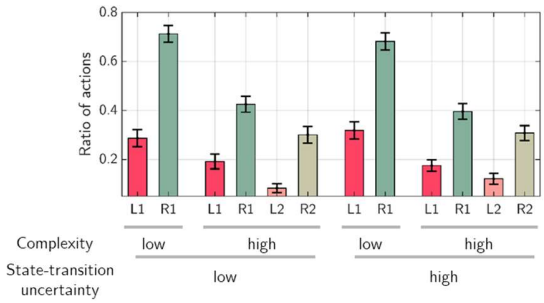
Measure: MEASURE_1

Source	UNCERTAINTY	COMPLEXITY	Type III Sum of Squares	df	Mean Square	F	Sig.
UNCERTAINTY	Linear		.004	1	.004	1.078	.310
Error(UNCERTAINTY)	Linear		.089	23	.004		
COMPLEXITY		Linear	.044	1	.044	12.935	.002
Error(COMPLEXITY)		Linear	.078	23	.003		
UNCERTAINTY * COMPLEXITY	Linear	Linear	.003	1	.003	.492	.490
Error (UNCERTAINTY*COMPLEXITY)	Linear	Linear	.156	23	.007		

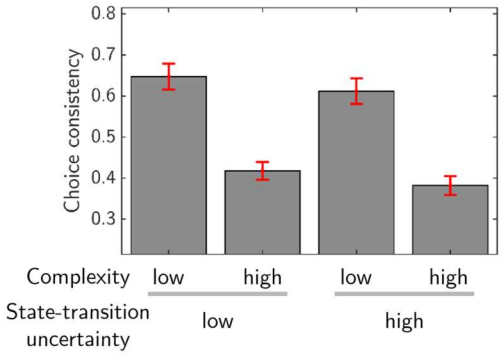
(2) stage 2

- Choice bias (left: state2, right, state3) : All the choice preference reflects value bias. Note that the choice bias is not a straightforward measure for quantifying the relationship between experimental conditions and behavior.





- choice consistency: We found main effects of uncertainty and complexity.



Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	UNCERTAINTY	COMPLEXITY	Type III Sum of Squares	df	Mean Square	F	Sig.
UNCERTAINTY	Linear		.030	1	.030	5.633	.026
Error(UNCERTAINTY)	Linear		.122	23	.005		
COMPLEXITY		Linear	1.263	1	1.263	97.093	.000
Error(COMPLEXITY)		Linear	.299	23	.013		
UNCERTAINTY * COMPLEXITY	Linear	Linear	1.284E-7	1	1.284E-7	.000	.996
Error (UNCERTAINTY*COMPLEXITY)	Linear	Linear	.092	23	.004		

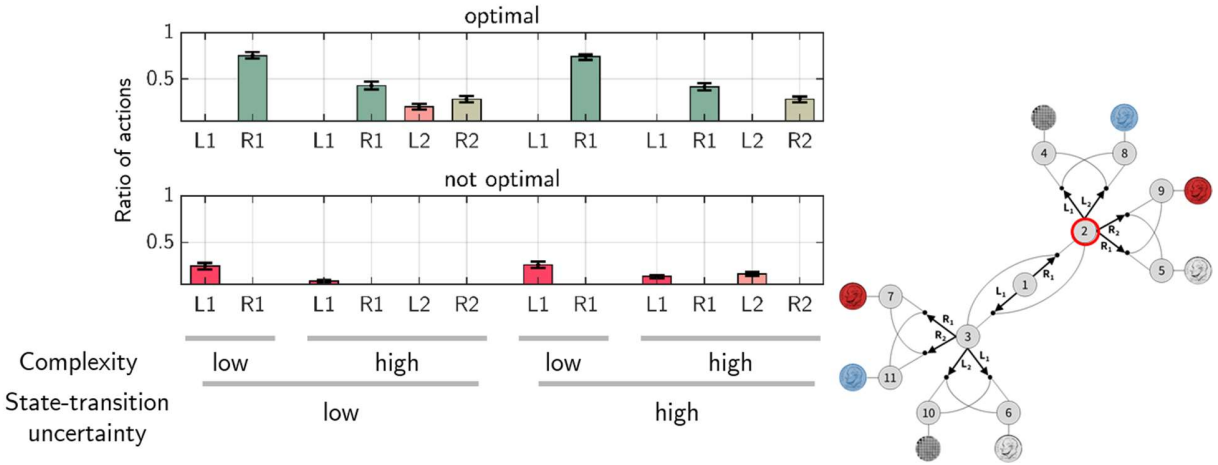
3. Number/percentage, and latency of choice for each of the four conditions and for the level of choice optimality (low vs high).

Note that behavioral analyses as a function of choice optimality is valid for the second stage only due to the task design in which all choices in the first stage are optimal in a high uncertainty condition.

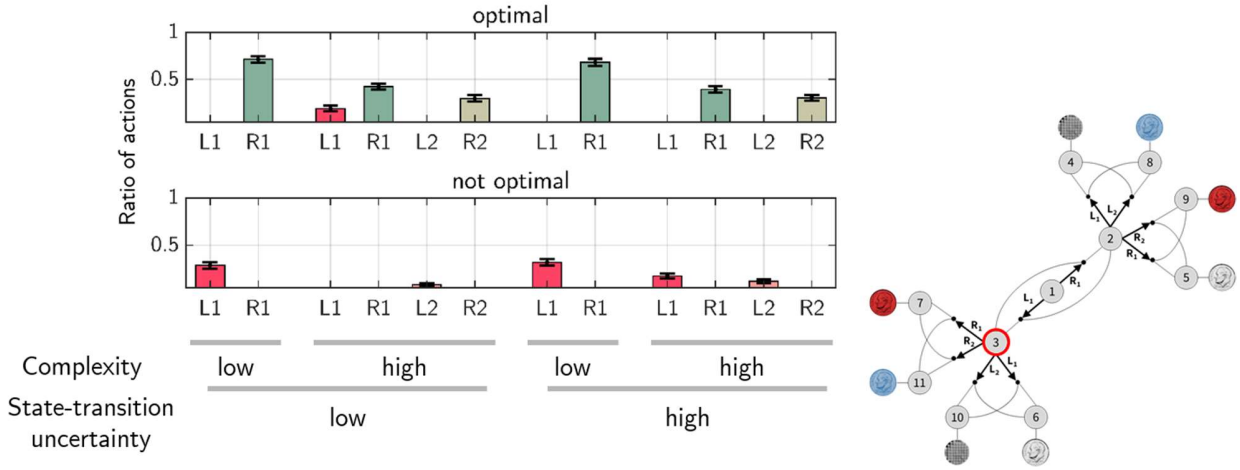
(1) Percentage of each choice

Subjects exhibit different choice patterns in each of the four separate conditions and for high vs. low high choice optimality. Fully consistent with the results of the choice optimality analysis, the number of non-optimal choices increases in the high uncertainty conditions.

- State 2

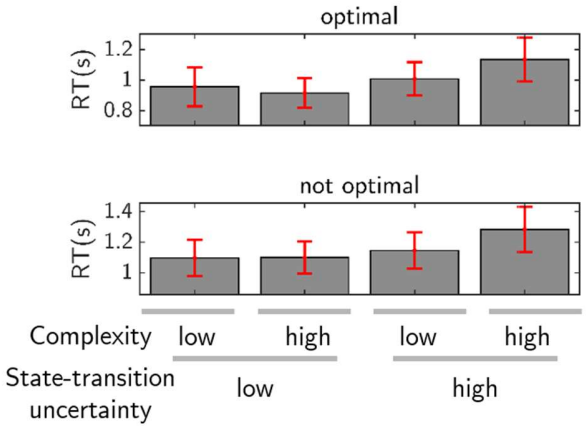


- State 3



(2) Latency (reaction-time): We found that an interaction effect of experimental conditions on RT is stronger when choice optimality is high than when it's low.

- Shown below are RT across all the experimental conditions for the low vs. high choice optimality.



Tests of Within-Subjects Contrasts **optimal**

Measure: MEASURE_1

Source	uncertainty	complexity	Type III Sum of Squares	df	Mean Square	F	Sig.
uncertainty	Linear		.441	1	.441	14.081	.001
Error(uncertainty)	Linear		.721	23	.031		
complexity		Linear	.043	1	.043	1.447	.241
Error(complexity)		Linear	.690	23	.030		
uncertainty * complexity	Linear	Linear	.166	1	.166	5.231	.032
Error (uncertainty*complexity)	Linear	Linear	.731	23	.032		

Tests of Within-Subjects Contrasts **not optimal**

Measure: MEASURE_1

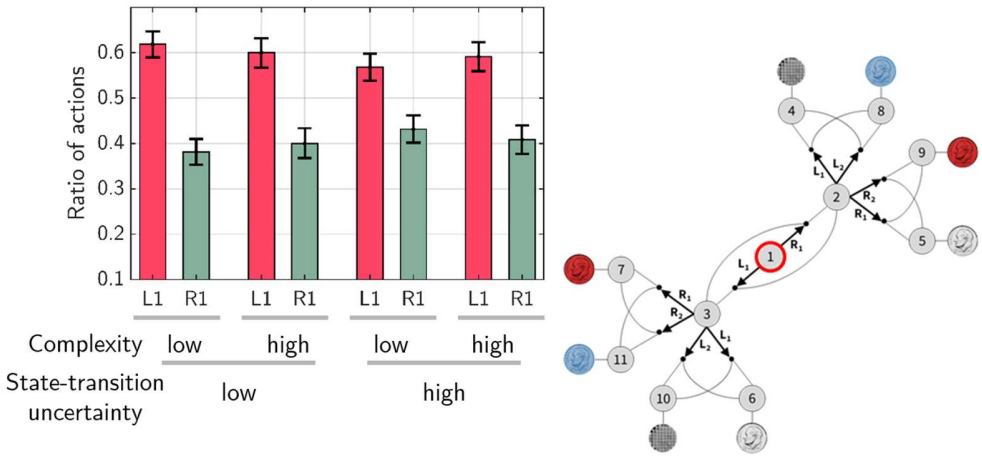
Source	uncertainty	complexity	Type III Sum of Squares	df	Mean Square	F	Sig.
uncertainty	Linear		.325	1	.325	5.400	.029
Error(uncertainty)	Linear		1.383	23	.060		
complexity		Linear	.120	1	.120	1.611	.217
Error(complexity)		Linear	1.716	23	.075		
uncertainty * complexity	Linear	Linear	.109	1	.109	4.259	.051
Error (uncertainty*complexity)	Linear	Linear	.588	23	.026		

In summary, the choice behavior (number/percentage and latency) reflects choice optimality.

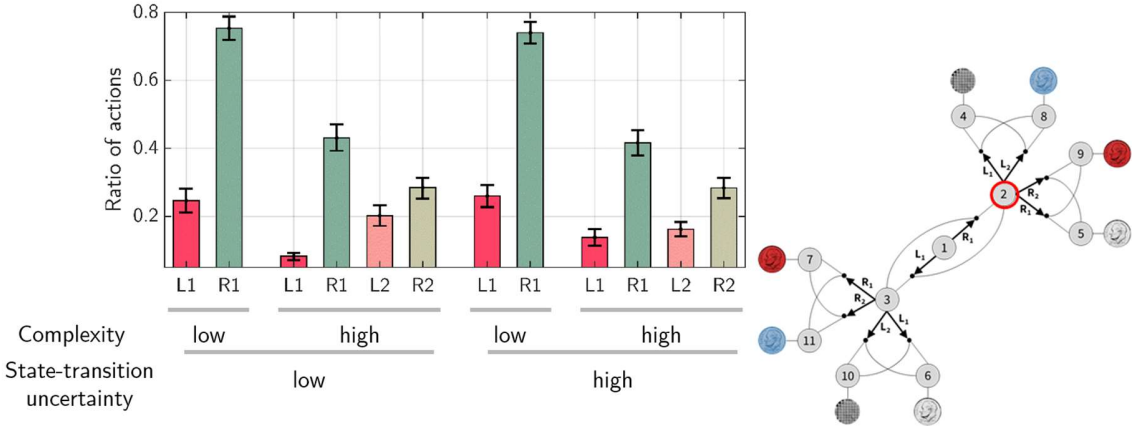
4. Effect of uncertainty and complexity on reaction time and choice behavior in each of the four conditions

(1) Percentage of each choice: Subjects prefer choices that are not associated with zero-value outcome state (state 4 and 10).

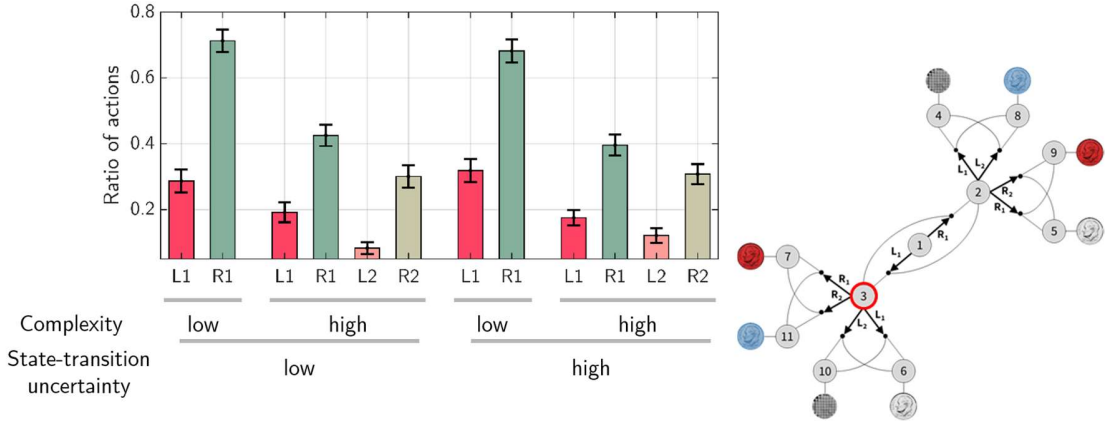
- State 1



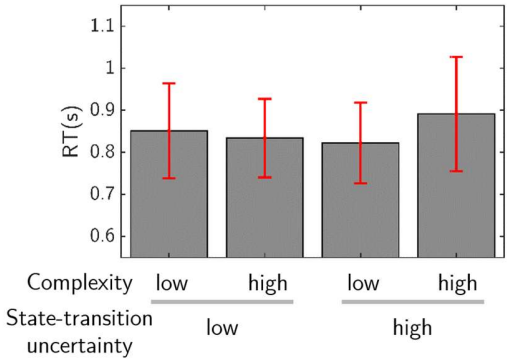
- State 2



- State 3



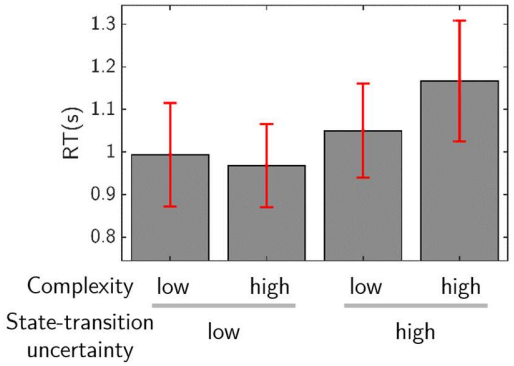
(2) Latency (reaction-time): We found an interaction effect of the experimental conditions on RT for the second stage.



Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	uncertainty	complexity	Type III Sum of Squares	df	Mean Square	F	Sig.
uncertainty	Linear		.005	1	.005	.484	.494
Error(uncertainty)	Linear		.229	23	.010		
complexity		Linear	.016	1	.016	2.633	.118
Error(complexity)		Linear	.144	23	.006		
uncertainty * complexity	Linear	Linear	.044	1	.044	1.683	.207
Error (uncertainty*complexity)	Linear	Linear	.608	23	.026		



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Error(uncertainty)	Linear		.723	23	.031		
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Error(complexity)		Linear	.683	23	.030		
uncertainty * complexity	Linear	Linear	.123	1	.123	5.219	.032
Error (uncertainty*complexity)	Linear	Linear	.541	23	.024		

In summary, despite the fact that these are very simple and noisy measures, we were still able to find effects of experimental conditions, albeit in some cases these effects do not reach statistical significance, likely because we are splitting the data in ways that substantially reduce our statistical power to detect meaningful effects.