

Supplementary Materials Online: Consciousness Influences the Enhancement of Visual Statistical Learning in Zipfian Distributions

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Supplementary Results

Galvin et al. (2003) emphasized that assuming a normal distribution in Type II tasks is unreasonable. In addition, Type II d' is influenced by the performance of Type I tasks. Thus, we calculated meta- d' and meta- d'/d' according to Maniscalco and Lau (2012, 2014). Meta- d' is a measure of metacognitive sensitivity unaffected by the performance of Type I tasks. Meta- d'/d' reflects metacognitive efficiency. Meta- $d'/d' = 1$ signifies using all information from Type I tasks in Type II tasks; meta- $d'/d' < 1$ indicates a lack of information; meta- $d'/d' > 1$ refers to using additional information (Maniscalco & Lau, 2012).

We used both *trials2counts.m* and *fit_meta_d_MLE.m* codes to estimate meta- d' (Maniscalco & Lau, 2012, 2014). Data from three participants were excluded from the uniform and one from the Zipfian distribution conditions because of the following error. The message was not produced in the low-frequency Zipfian distribution condition when estimating meta- d' .

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Error using barrier
Objective function is undefined at initial point. fmincon cannot
continue.
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Similar to the results of Type II d' , a significant difference was detected in meta- d' between the uniform and Zipfian distribution conditions, $t(62) = 2.18$, $p = .033$, $BF_{10} = 1.86$, $d = 0.54$, 95% CI [0.05, 1.14]. This difference indicated that meta- d' in the Zipfian distribution (mean = 1.73, $SE = 0.21$) was significantly larger than in the uniform distribution condition (mean = 1.13, $SE = 0.17$). However, meta- d' in the low-frequency Zipfian distribution (mean = 1.40, $SE = 0.21$) was similar to the uniform distribution condition $t(63) = .976$, $p = .333$, $BF_{10} = 0.38$, $d = 0.24$, 95% CI [-0.28, 0.81]. Furthermore, meta- d'/d' was significantly higher than 1 in the Zipfian distribution condition, mean = 1.07 ($SE = 0.14$), $t(32) = 3.47$, $p = .002$, $BF_{10} = 0.21$, $d = 0.59$, 95% CI [1.30, 2.15]. This value was marginally lower than 1 in the low-frequency Zipfian distribution condition, mean = 0.97 ($SE = 0.16$), $t(33) = 1.91$, $p = .065$, $BF_{10} = 0.19$, $d = 0.32$, 95% CI [0.97, 1.82]. However, meta- d'/d' in the uniform distribution condition was not significantly different from 1, mean = 0.97 ($SE = 0.33$), $V = 295.00$, $p = .367$, $BF_{10} = 0.19$, $r = 0.16$, 95% CI [0.78, 1.48].¹ Note that Bayes factor values in one-sample tests were under 1 in all conditions. These results suggest that Zipfian distributions enhance metacognitive sensitivity to familiarity decisions. Moreover, all information was utilized in the post-decision wagering task across distribution conditions.

References

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¹ We conducted a Wilcoxon signed-rank test because a Shapiro-Wilk test showed a deviation from normality ($W = .841$, $p < .001$).

Supplementary Table 1

Line drawings arranged into each triplet in the uniform distribution condition

participants	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	cat	key	butterfly	chair	ball	fish	bottle	watch	fork	car	flower	book	dog	shoe	airplane	cake	house	banana
2	flower	dog	cake	fish	ball	car	cat	watch	key	shoe	chair	airplane	banana	house	bottle	fork	butterfly	book
3	cake	key	bottle	cat	house	fish	car	fork	flower	airplane	shoe	ball	chair	book	butterfly	banana	watch	dog
4	fork	book	fish	dog	house	airplane	bottle	key	chair	watch	cake	flower	car	ball	banana	butterfly	cat	shoe
5	fork	cat	butterfly	airplane	book	flower	fish	ball	chair	banana	key	watch	house	dog	cake	shoe	bottle	car
6	flower	butterfly	cake	shoe	fork	car	chair	dog	ball	house	bottle	banana	airplane	cat	book	key	fish	watch
7	key	airplane	butterfly	book	cat	bottle	fish	car	chair	flower	ball	banana	house	watch	cake	dog	fork	shoe
8	key	book	cake	fork	airplane	dog	bottle	shoe	butterfly	banana	watch	house	flower	ball	chair	car	fish	cat
9	banana	fish	watch	dog	chair	butterfly	shoe	airplane	house	ball	car	book	cat	cake	bottle	key	fork	flower
10	shoe	house	chair	cat	fish	flower	banana	cake	watch	ball	butterfly	fork	book	key	bottle	dog	airplane	car
11	ball	book	shoe	cat	dog	butterfly	car	chair	airplane	banana	bottle	fork	watch	key	flower	cake	fish	house
12	fork	chair	banana	watch	book	key	airplane	bottle	car	house	dog	ball	shoe	cat	fish	flower	butterfly	cake
13	house	fish	ball	butterfly	fork	shoe	cake	chair	watch	cat	car	book	airplane	key	banana	flower	dog	bottle
14	ball	book	fish	chair	house	fork	bottle	key	cat	airplane	shoe	watch	flower	car	butterfly	dog	cake	banana
15	fish	cat	house	car	fork	dog	cake	airplane	bottle	ball	shoe	butterfly	watch	banana	book	flower	chair	key
16	butterfly	watch	fork	chair	airplane	dog	cat	bottle	house	fish	ball	car	cake	key	book	flower	shoe	banana
17	flower	cat	cake	fork	chair	fish	car	shoe	ball	dog	watch	bottle	banana	book	airplane	butterfly	key	house
18	key	shoe	ball	watch	butterfly	fork	airplane	cat	flower	dog	cake	chair	book	house	bottle	banana	fish	car
19	house	dog	cake	fork	cat	chair	ball	flower	shoe	watch	book	fish	butterfly	bottle	car	banana	key	airplane
20	shoe	flower	fork	bottle	watch	banana	cake	butterfly	car	cat	dog	house	fish	book	ball	airplane	chair	key
21	shoe	banana	bottle	dog	fish	cake	fork	cat	house	flower	butterfly	chair	airplane	key	car	ball	watch	book
22	cat	butterfly	flower	house	cake	chair	fork	car	fish	dog	bottle	key	airplane	ball	banana	shoe	book	watch
23	cat	watch	ball	cake	butterfly	house	bottle	key	fish	banana	chair	airplane	flower	book	car	dog	fork	shoe
24	key	dog	cat	cake	fork	bottle	chair	banana	house	book	watch	flower	ball	shoe	airplane	butterfly	car	fish
25	book	cake	fish	car	flower	airplane	house	shoe	watch	bottle	butterfly	dog	ball	key	fork	chair	banana	cat
26	house	dog	ball	cat	key	chair	fork	shoe	car	flower	bottle	fish	banana	butterfly	book	airplane	cake	watch
27	ball	watch	fork	book	car	fish	banana	dog	cat	flower	airplane	butterfly	bottle	cake	key	house	shoe	chair
28	banana	shoe	car	book	cat	fork	airplane	chair	house	cake	dog	butterfly	watch	flower	key	bottle	fish	ball
29	house	ball	book	flower	dog	car	bottle	shoe	cat	fork	banana	fish	watch	airplane	cake	key	chair	butterfly
30	ball	fish	house	fork	chair	banana	airplane	cat	bottle	book	key	cake	watch	flower	shoe	dog	car	butterfly
31	fork	book	cat	bottle	car	butterfly	banana	watch	key	house	chair	flower	ball	airplane	cake	dog	shoe	fish
32	cat	fork	butterfly	car	house	key	ball	dog	airplane	fish	flower	watch	shoe	banana	chair	cake	bottle	book
33	cake	fork	key	house	fish	banana	bottle	book	shoe	car	dog	watch	cat	butterfly	ball	chair	flower	airplane
34	book	fish	butterfly	cake	banana	cat	ball	car	bottle	chair	fork	house	watch	airplane	shoe	flower	dog	key
35	cat	chair	house	airplane	banana	watch	book	flower	shoe	fork	ball	car	cake	dog	fish	key	bottle	butterfly

Supplementary Table 2

Line drawings arranged into each triplet in the Zipfian distribution condition

participants	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	house	bottle	cake	shoe	fork	flower	fish	car	dog	watch	butterfly	airplane	book	ball	chair	cat	banana	key
2	butterfly	fish	flower	banana	key	shoe	dog	house	watch	cat	car	chair	fork	book	ball	airplane	bottle	cake
3	shoe	airplane	bottle	book	banana	dog	cat	chair	flower	ball	car	house	key	butterfly	cake	fish	fork	watch
4	fish	ball	dog	airplane	house	cake	butterfly	car	cat	book	key	flower	fork	shoe	bottle	banana	chair	watch
5	airplane	butterfly	flower	car	banana	cake	chair	key	fork	watch	book	dog	ball	house	fish	cat	shoe	bottle
6	dog	bottle	watch	airplane	flower	car	ball	fish	house	banana	butterfly	chair	cat	fork	book	key	shoe	cake
7	ball	fork	butterfly	fish	bottle	key	airplane	cat	book	watch	shoe	banana	dog	flower	house	car	cake	chair
8	banana	ball	bottle	cat	house	airplane	car	fish	shoe	flower	chair	butterfly	fork	key	book	watch	dog	cake
9	watch	butterfly	banana	cake	dog	car	bottle	airplane	house	flower	fork	shoe	ball	chair	fish	key	cat	book
10	banana	cat	cake	book	fork	key	bottle	watch	car	fish	chair	ball	butterfly	flower	shoe	house	airplane	dog
11	butterfly	fork	ball	dog	house	airplane	chair	cake	watch	flower	key	cat	book	banana	bottle	fish	shoe	car
12	dog	cake	watch	shoe	cat	chair	bottle	house	fork	butterfly	flower	book	car	ball	banana	key	fish	airplane
13	chair	fork	airplane	ball	cake	cat	banana	flower	bottle	car	watch	key	shoe	fish	butterfly	book	house	dog
14	fork	cake	ball	banana	bottle	book	airplane	flower	butterfly	dog	chair	house	fish	cat	key	car	watch	shoe
15	shoe	fork	flower	banana	bottle	chair	car	butterfly	book	house	dog	fish	cake	airplane	cat	watch	key	ball
16	book	cat	bottle	butterfly	chair	cake	fish	key	car	banana	dog	ball	fork	flower	shoe	house	airplane	watch
17	shoe	house	banana	key	fork	fish	airplane	dog	watch	cat	cake	ball	book	bottle	chair	flower	butterfly	car
18	watch	banana	ball	chair	car	airplane	flower	fish	fork	cake	shoe	house	key	cat	book	bottle	dog	butterfly
19	banana	cat	fork	butterfly	shoe	bottle	chair	cake	ball	house	car	dog	watch	flower	key	fish	book	airplane
20	flower	airplane	house	butterfly	fish	dog	ball	chair	shoe	fork	watch	book	cake	car	cat	bottle	banana	key
21	bottle	house	flower	watch	cat	key	fish	ball	dog	book	airplane	chair	car	banana	butterfly	cake	fork	shoe
22	flower	butterfly	cat	fork	cake	shoe	house	airplane	dog	bottle	ball	book	banana	key	chair	fish	watch	car
23	book	shoe	watch	airplane	house	dog	bottle	fork	key	chair	cake	car	flower	butterfly	banana	fish	ball	cat
24	watch	shoe	fish	butterfly	flower	book	chair	airplane	car	house	cake	fork	dog	cat	ball	bottle	banana	key
25	shoe	dog	flower	airplane	house	fork	banana	car	bottle	key	cat	book	butterfly	chair	cake	ball	watch	fish
26	fish	dog	key	fork	airplane	butterfly	watch	house	ball	car	flower	chair	cake	bottle	banana	book	cat	shoe
27	shoe	fork	airplane	banana	flower	watch	key	book	ball	cat	dog	house	cake	butterfly	car	fish	chair	bottle
28	watch	fish	fork	car	chair	shoe	house	cat	banana	cake	flower	dog	airplane	bottle	ball	book	key	butterfly
29	watch	chair	house	fish	bottle	dog	ball	butterfly	key	banana	shoe	book	fork	car	cake	flower	airplane	cat
30	car	cat	cake	key	banana	ball	watch	book	house	butterfly	dog	chair	bottle	fork	flower	airplane	shoe	fish
31	butterfly	fork	ball	cat	key	chair	book	fish	car	dog	watch	flower	airplane	cake	bottle	banana	shoe	house
32	key	airplane	fish	house	car	cat	book	ball	banana	dog	fork	bottle	cake	shoe	watch	chair	flower	butterfly
33	key	airplane	chair	shoe	flower	house	book	cake	ball	bottle	fork	fish	car	watch	banana	butterfly	cat	dog
34	chair	car	flower	banana	fork	cake	shoe	book	house	fish	key	butterfly	ball	airplane	cat	bottle	watch	dog
35	house	cat	fish	cake	chair	key	watch	book	car	airplane	butterfly	ball	bottle	banana	flower	fork	dog	shoe
36	watch	car	chair	fork	shoe	dog	banana	butterfly	cake	airplane	fish	flower	house	cat	book	ball	bottle	key
37	shoe	car	airplane	dog	fork	house	fish	flower	cat	chair	cake	banana	bottle	key	watch	butterfly	ball	book
38	banana	flower	car	airplane	dog	ball	chair	watch	shoe	key	butterfly	cake	house	book	bottle	fork	cat	fish
39	house	banana	cake	butterfly	cat	flower	dog	ball	key	airplane	fork	bottle	car	watch	chair	book	shoe	fish