Supplementary experiment: Influence of limited number of stimulus panels

In the present study, we prepared panels with six different configurations for each number and randomly paired these panels in the experiments. These manipulations were designed to eliminate as much as possible the use by the dolphins of cues unrelated to the quantities, such as the presence or absence of an object at a particular location in the panel or a particular geometric pattern in the panel. However, only six patterns might not be enough, given that nonhuman animals can remember a very large number of stimuli. Our dolphins in the present study may not have been making "relative" quantity judgments but rather doing something completely different, such as memorizing all the patterns.

Therefore, we conducted an additional simulation experiment to gain some insight into this possibility. In this experiment, we assumed that the (simulated) dolphins did not make "relative" quantity judgments but instead chose a particular panel by attending to only one or two locations in the panel. If there was an object at the attended location(s), they chose that panel with 100% probability, whereas if there was an object (or no object) at that location in both panels, they chose the panel with 50% probability.

The simulation experiment was conducted under two conditions: one in which only one location was attended and the other in which two locations that could form a minimal geometric pattern were attended. In each simulation trial, we first generated a random pattern of object configurations on the panel. Then, for each trial, the simulation program also randomly determined which of the 15 (5x3) locations on the panel would be attended.

Figure SF1 shows examples of panel patterns generated in this way (the case of 5 vs. 3). Black or dotted circles indicate the attended location and black or white circles indicate the location where the object was placed. Dotted circles indicate the attended but empty location. If there is an

object in the attended location in the 5-object panel but not in the 3-object panel (the top row of the figure), the simulated dolphin will always choose the correct panel (five objects). On the other hand, if there is an object in the attended location but only in the 3-object panel, the dolphin will always choose the 3-object panel (always incorrect; the bottom row of the figure). If there is an object or no object in the attended locations of both panels, one of the panels is chosen 50% of the time, and so on. In the case of two attended locations (right side of the figure), if there is an object in only one of the two locations, that panel is chosen. Under these rules, 100,000 random simulations were performed for each pair to obtain the expected correct response rate. The simulation program was written in Visual Basic 6.0®.

The results of the simulation are presented in Table SF1. Figure SF2 also shows the comparisons of the correct response rates between the simulations and the real dolphins in Experiments 1 and 2. These results were analyzed using paired t-tests (results are presented in the main text).

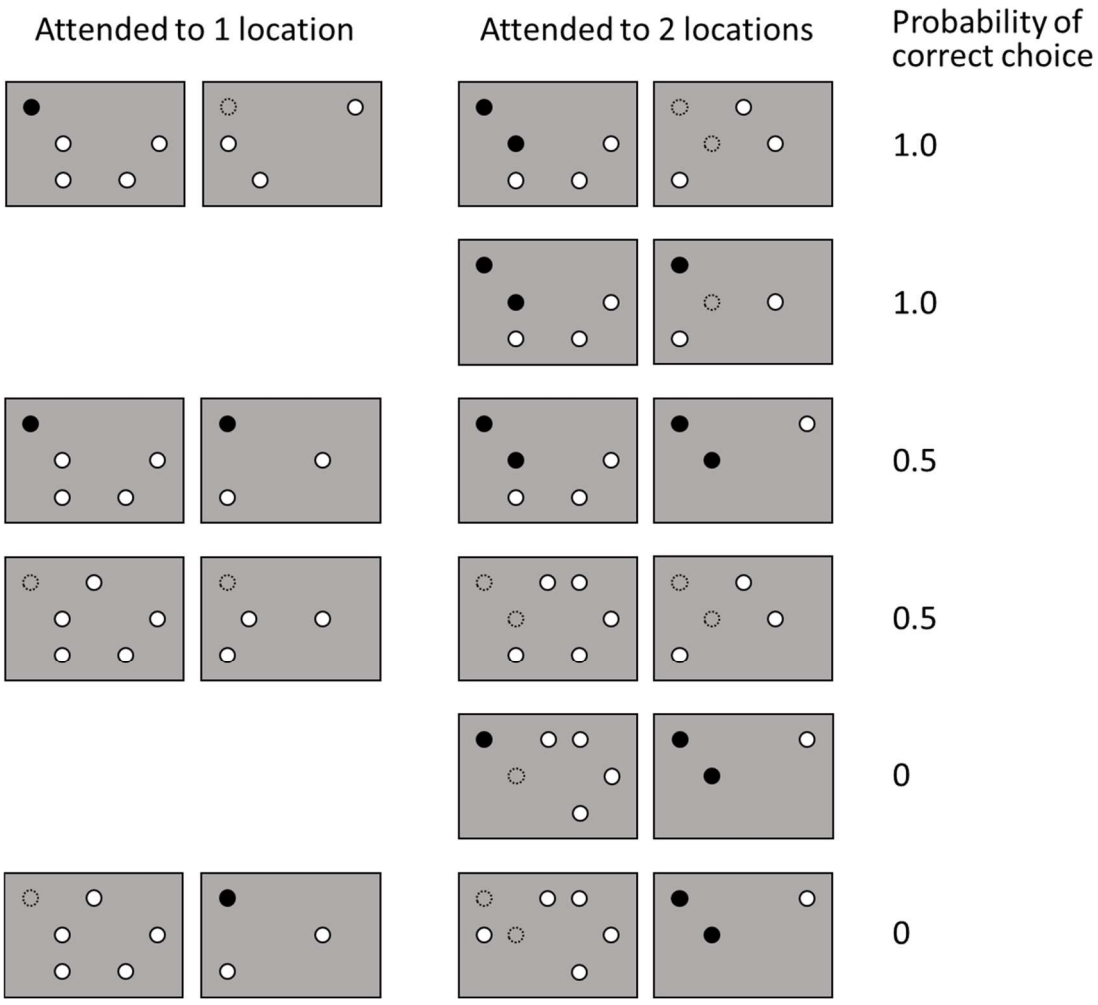
Table SF1.

Results of Simulation Experiment

		Simulated accuracy (% Correct)	
Large	Small	1 location	2 locations
2	1	53.3	56.2
3	1	56.7	59.5
3	2	53.2	58.3
4	1	59.9	62.8
4	2	56.6	61.5
4	3	53.3	60
5	1	63.4	65.8
5	2	60.1	64.8
5	3	56.8	62.8
5	4	53.2	60.7
6	1	66.6	69.3
6	2	63.1	67.8
6	3	59.9	66
6	4	56.5	63.5
6	5	53.2	61.6
7	1	70.1	72.6
7	2	66.7	70.9
7	3	63.6	69.3
7	4	60.1	66.9
7	5	56.8	64.2
7	6	53.3	60.9
8	1	73.3	75.7
	Mean	59.5	64.6
	SEM	1.3	1.0

Figure SF1

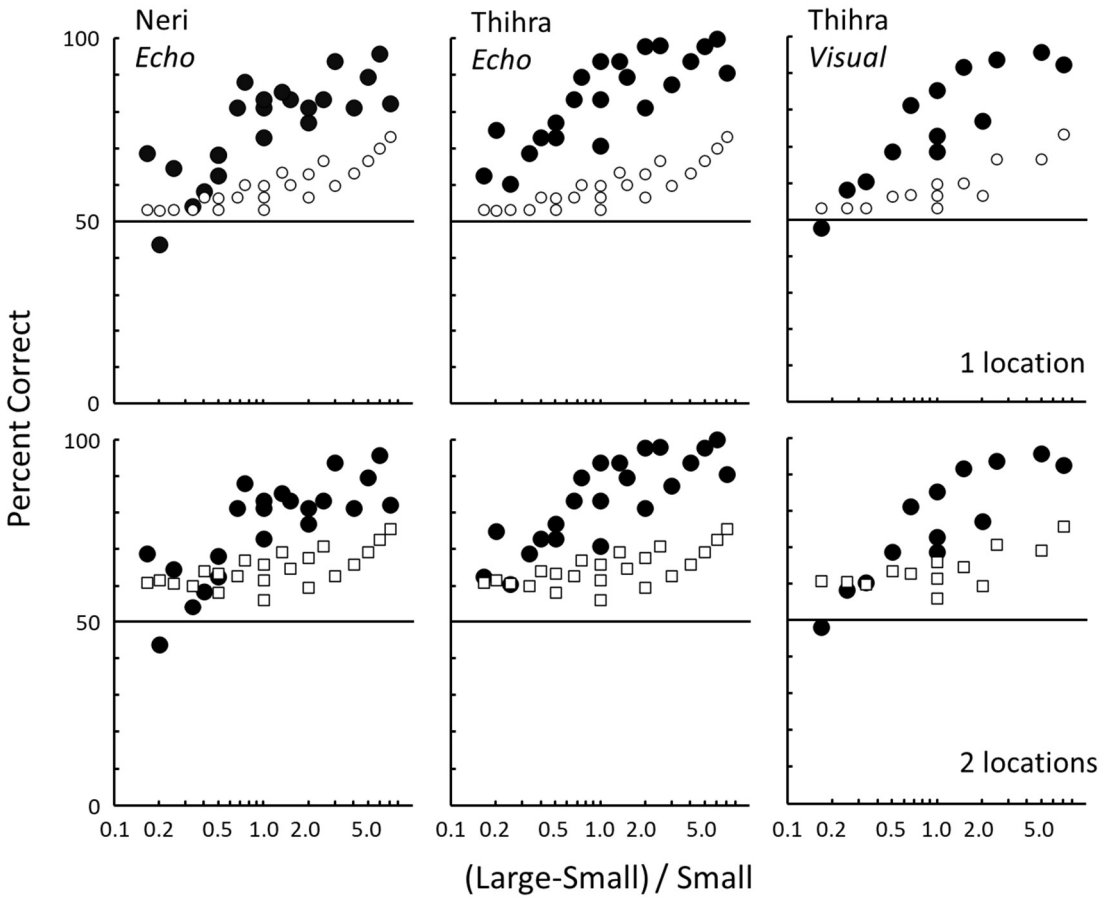
Examples of Panel Patterns Generated by the Simulation Program (The Case of 5 vs. 3)



Note. Black or dotted circles indicate the attended location. Black or white circles indicate the location where the object was placed. Dotted circles indicate the attended but empty location.

Figure SF2.

Comparisons of the Correct Response Rates Between the Simulations and the Real Dolphins



Note. Black circles indicate the results of the real dolphins. Open symbols indicate the results of simulations.