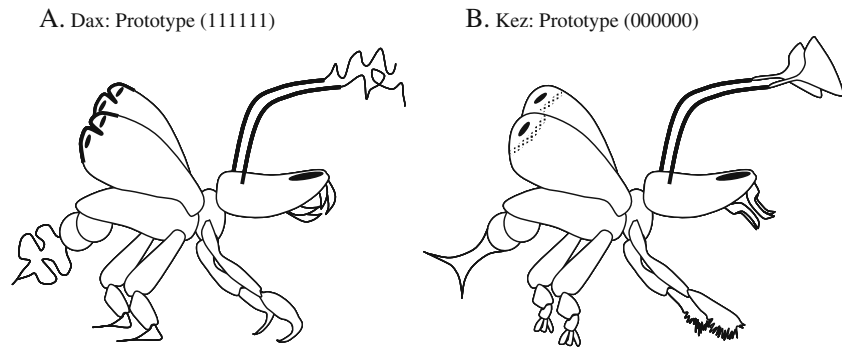
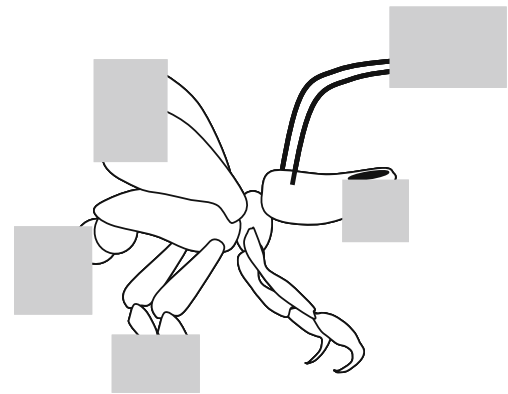


**Fig. 1** Example prototypes of the Dax and Kez categories



**Table 1** Abstract structure for the Dax and Kez categories

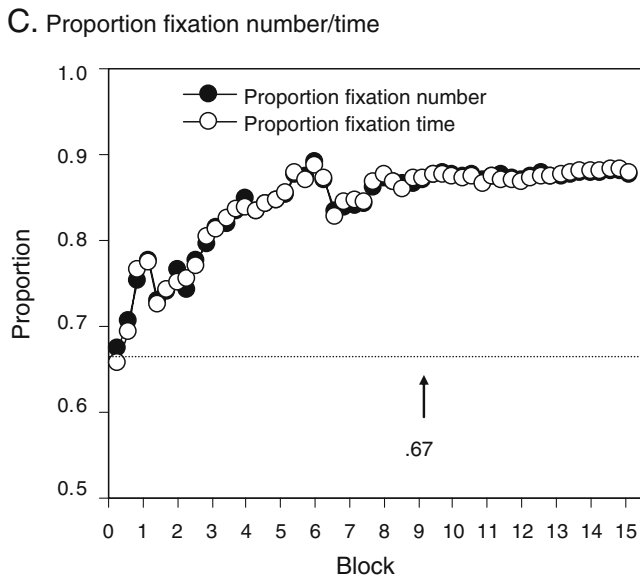
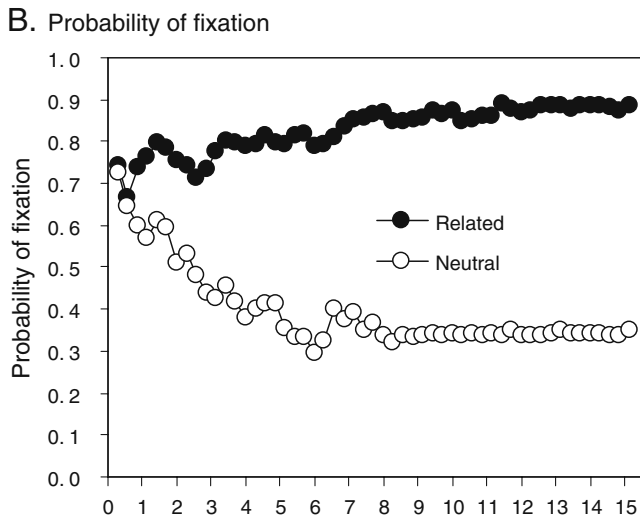
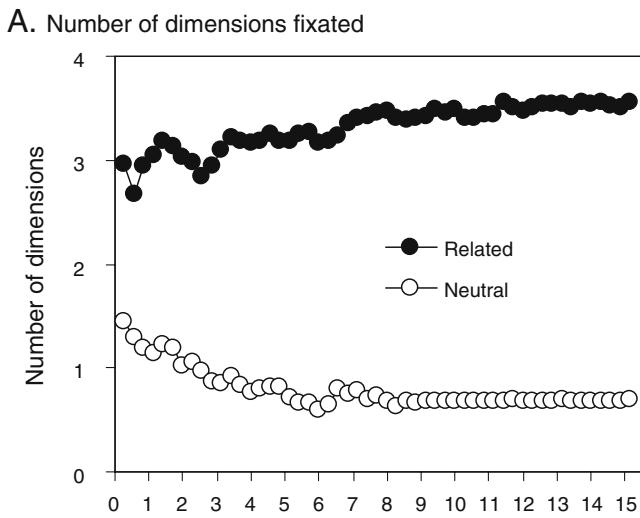
Exemplars	Dimensions					
	Tail	Foot	Wing	Mouth	Forearm	Antenna
Dax						
D0	1	1	1	1	1	1
D1	1	1	1	1	1	0
D2	1	1	1	1	0	1
D3	1	1	1	0	1	1
D4	1	1	0	1	1	1
D5	1	0	1	1	1	1
D6	0	1	1	1	1	1
Kez						
K0	0	0	0	0	0	0
K1	0	0	0	0	0	1
K2	0	0	0	0	1	0
K3	0	0	0	1	0	0
K4	0	0	1	0	0	0
K5	0	1	0	0	0	0
K6	1	0	0	0	0	0



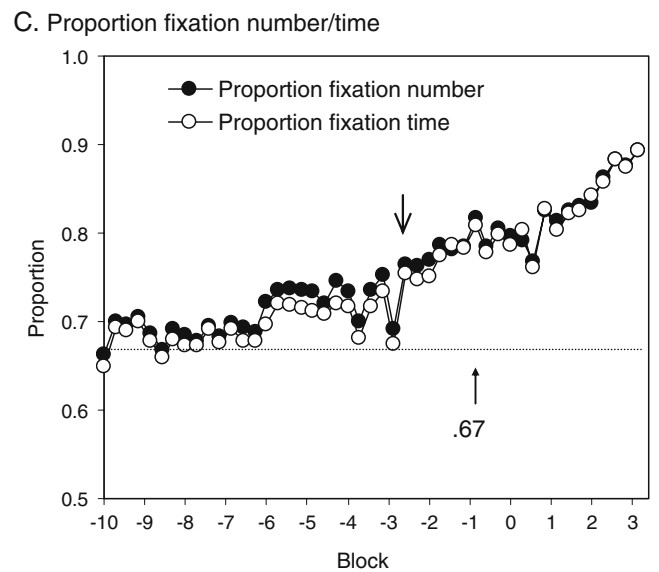
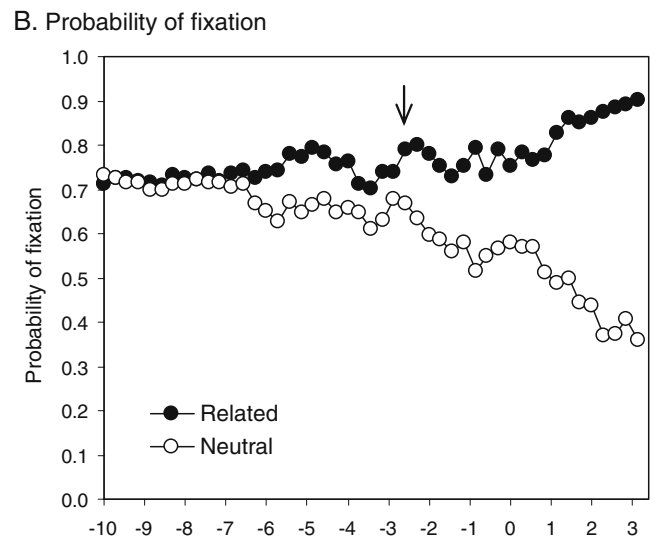
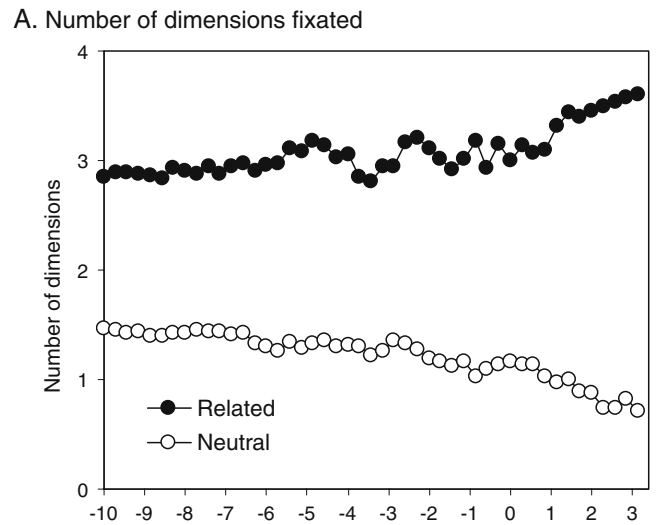
**Fig. 2** An example of a multiple-choice question

**Table 2** Example feature descriptions for the Dax and Kez prototypes in Fig. 1. Four related dimensions were associated with either a cold or a hot climate. The other two neutral dimensions were unrelated to these themes

Dimension	Dax [tundra/cold theme]	Kez [desert/hot theme]
Related		
Antenna	Because the temperature is very low, parts of ants' eyes (e.g., cornea, iris, pupil) often freeze and the ants become blind. When that happens, this thread type of flexible antennae is used to detect close objects.	Because the air is hot and dry, the ants are vulnerable to dehydration. To maintain hydration, the ants use this fan type of antennae to absorb water vapor from the air.
Mouth	Because the ground is frozen, the ants need to cut and break tough soil in search of their food. This type of mouth with sharp incisors serves this function.	Because sources of food are covered with sand, they need to be cleared before swallowing. The inner surface of the ants' mouth has short but stiff hairs that filter out these impurities.
Forearm	Because of frequent blizzards, the ants need to anchor themselves during high winds. This type of forearm allows the ant to hold its position.	Because the ants' preys (e.g., fleas) hide in sand, the ants use this type of forearm to sweep the sand and detect the prey.
Foot	Because the ground surface is slippery, the ants need to have wide feet to maintain their footing.	Because the ground surface is extremely hot, the ants switch the toe that comes into contact with the ground in each step to avoid burning.
Neutral		
Tail	The ants feed proteins stored in the humps to their larvae using the sharp nozzle in the end of tail.	The ants lay a large number of eggs at a time. This trumpet-shaped tail allows the ants to deliver a large number of eggs.
Wings	While flying, the ants control their rapid changes in direction by adjusting the fore- and rear-flaps in each wing.	The ants have red spots in the wing ends. The color becomes brighter in the mating season by the hormones produced in the gray area.



**Fig. 3** Eye-fixations results from [Experiment 2](#). (a) Number of related/neutral dimensions fixated. (b) Probability of fixation to the related/neutral dimensions. (c) Proportion fixation number/time. The 0.67 (= 4/6) line reflects fixation proportion in favor of neither dimension types



**Fig. 4** Backward learning curves from [Experiment 2](#). (a) Number of related/neutral dimensions fixated. (b) Probability of fixation to the related/neutral dimensions. (c) Proportion fixation number/time

**Table 3** Single-feature test results from Experiments 1 and 2 (learners only)

	Related condition		Unrelated condition
	Related dimensions	Neutral dimensions	Neutral dimensions
<b>Experiment 1</b>			
Accuracy	0.89	0.71	0.76
Signed confidence rating	67.1	37.0	43.8
RT (seconds)	2.9	4.1	3.5
<b>Experiment 2</b>			
Accuracy	0.91	0.70	
Signed confidence rating	73.6	29.1	
RT (seconds)	2.6	4.0	

## Appendix

### Materials for Experiments 1 and 2

The features and their associated knowledge are presented. There were 12 features, two features for each of the six dimensions. For each feature, three types of knowledge (i.e., Tundra, Desert, & Neutral) were invented resulting in 36 descriptions in total.

#### Antenna (0)



$0_t$ : The ants need to photosynthesize amino acids to sustain their life. Because the daytime is short, they use this fan type of antennae to maximize the surface area exposed to the sunlight.

$0_d$ : Because the air is hot and dry, the ants are vulnerable to dehydration. To maintain hydration, the ants use this fan type of antennae to absorb water vapor from the air.

$0_n$ : The ants use sunlight and moonlight to orient themselves. This fan-like antennae allows to absorb enough light for purpose of orientation.

#### Antenna (1)



$1_t$ : Because the temperature is very low, parts of ants' eyes (e.g., cornea, iris, pupil) often freeze and the ants become blind. When that happens, this thread type of flexible antennae is used to detect close objects.

$1_d$ : Because the temperature is very high, the ants need to dissipate excess body heat. This thread type of antennae promotes heat dissipation.

$1_n$ : The ants become blind at night and use this thread type of antennae to detect close objects.

#### Foot (0)



$0_t$ : Because the ground surface is extremely cold, the ants conserve body heat by switching the toe that comes into contact with the ground in each step.

$0_d$ : Because the ground surface is extremely hot, the ants switch the toe that comes into contact with the ground in each step to avoid burning.

$0_n$ : The ants communicate through chemicals called pheromones. Each of these three toes releases a unique chemical to convey different messages.

#### Foot (1)



$1_t$ : Because the ground surface is slippery, the ants need to have wide feet to maintain their footing.

$1_d$ : Because of the sandy soil, the ants have wide feet that prevent them from sinking below the surface.

$1_n$ : The ants protect themselves from enemies approaching from behind by kicking with these sharp protrusions.

Forearm (0)



- 0<sub>t</sub>: Because the ground is slippery in the ants' environment, the forearm with thorn-like protrusions helps the ants to move without slipping.
- 0<sub>d</sub>: Because the ants' prey (e.g., fleas) hide in sand, the ants use this type of forearm to sweep the sand and detect the prey.
- 0<sub>n</sub>: When the ants engage in a fight, they use this saw-like forearm to tear the enemy apart.

Forearm (1)



- 1<sub>t</sub>: Because of frequent blizzards, the ants need to anchor themselves during high winds. This type of forearm allows the ant to hold its position.
- 1<sub>d</sub>: Because of strong direct sunlight, the ants dig deep into the ground in order to be cool when they rest. This type of forearm helps the ants to do the job easier and faster.
- 1<sub>n</sub>: The ants sometimes plunder other ants' colony of eggs. This hook-type of forearm is useful in digging in search of the eggs.

Mouth (0)



- 0<sub>t</sub>: Because sources of food are frozen and tough, the ants mash and grind them using the upper and lower parts of the mouth before swallowing.
- 0<sub>d</sub>: Because sources of food are covered with sand, they need to be cleared before swallowing. The inner surface of the ants' mouth has short but stiff hairs that filter out these impurities.
- 0<sub>n</sub>: The ants are herbivorous. This long mouth is used to grind tough fibroid materials in plants before they are swallowed.

Mouth (1)



- 1<sub>t</sub>: Because the ground is frozen, the ants need to cut and break tough soil in search of their food. This type of mouth with sharp incisors serves this function.
- 1<sub>d</sub>: Because the air is dry and the sunlight is strong, food dries out quickly. The ants hold their food in the cavity of their mouth on the way to their nest so that the food does not become dry.
- 1<sub>n</sub>: The ants need to transport food to their colony. This mouth allows them to hold the food in the cavity of their mouth until they arrive at their colony.

Tail (0)



- 0<sub>t</sub>: Because water tends to exist in a frozen state, the ants acquire water by collecting dew drops with this trumpet-shaped tail early in every morning.
- 0<sub>d</sub>: Because the air is dry and water is scarce, the ants need to collect water whenever possible. This trumpet-shaped tail is used to collect rain during the rare rainstorm.
- 0<sub>n</sub>: The ants lay a large number of eggs at a time. This trumpet-shaped tail allows the ants to deliver a large number of eggs.