Science Education Collection

Visual Statistical Learning

URL: http://www.jove.com/science-education/10063

Overview

Source: Laboratory of Jonathan Flombaum—Johns Hopkins University

The visual environment contains massive amounts of information involving the relations between objects in space and time; certain objects are more likely to appear in the vicinity of other objects. Learning these regularities can support a wide array of visual processing, including object recognition. Unsurprisingly, then, humans appear to learn these regularities automatically, quickly, and without conscious awareness. The name for this type of implicit learning is visual statistical learning. In the laboratory, it is studied with an incidental-encoding paradigm: participants observe a stream of nonsense objects and complete a cover-task, a task unrelated to the underlying statistical structure in the stream. But statistical structure is present, and subsequent to a short exposure period—as short as 10 min in some experiments—a familiarity test reveals the extent of learning by the participants.

This video will demonstrate standard methods for inducing and testing visual statistical learning.

Procedure

1. Generate a set of nonsense objects and arrange them into a triplet structure.

1. Often visual statistical learning is studied with simple objects like the set below. Generate a set of objects, and then group them into triplets (**Figure 1**).

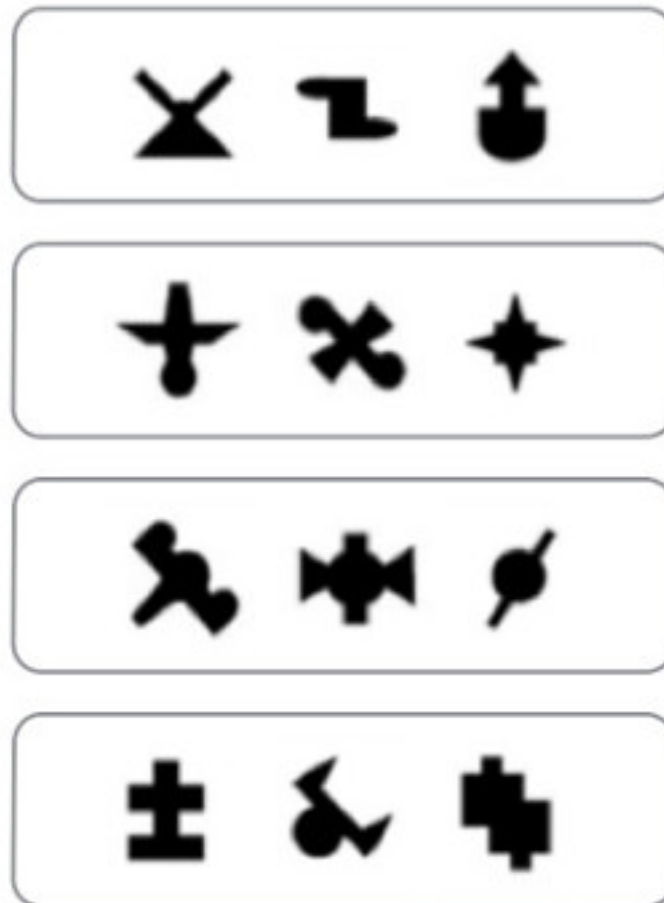## Sample Stimuli Grouped into Triplets for Visual Statistical Learning

Figure 1. Sample stimuli grouped into triplets for visual statistical learning. In the learning segment of an experiment, triplets will appear in random order, but the items within a triplet will always appear in order, with the item on the left appearing first followed successively by the items to its right.

2. Sequence the experiment.

1. Sequence the experiment with software such as e-Prime, or by using a routine library such as Psychophysics Toolbox in MATLAB, or PsycoPy for Python.
2. The nonsense objects are displayed in the center of the screen, one-at-a-time, for 250 ms each.
3. Instruct the program to always show members of a triplet in sequence, and to choose which triplet to show next randomly, ending up with sequences similar to **Figure 2**.

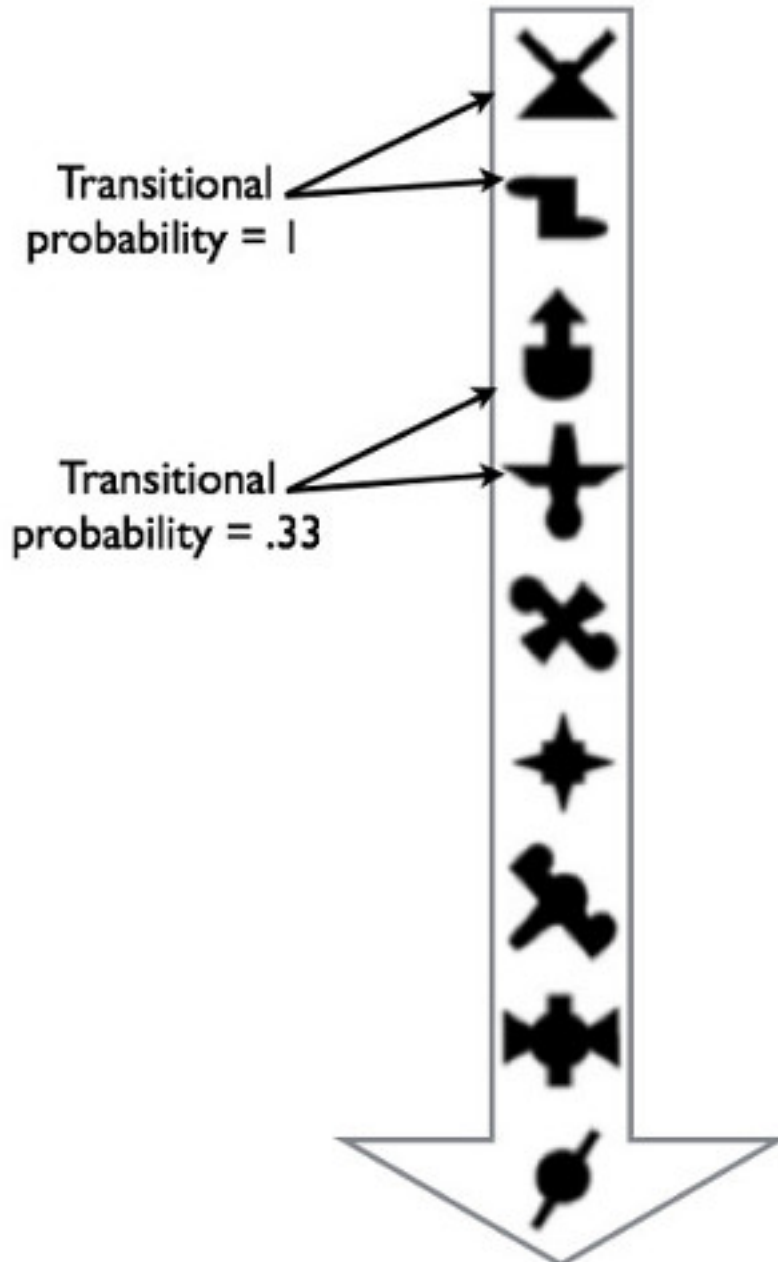# Sample Learning Sequence for Visual
Statistical Learning

Figure 2. Sample learning sequence for visual statistical learning. The triplets appear in a random order such that the transitional probability for items in different sequences is about 0.33, while the transitional probability within a sequence is 1.

4. Note that because triplets always appear in sequence, the transitional probability between elements of a triplet is always 1. But because transitions between triplets are selected randomly, transitional probabilities between unrelated elements are considerably lower, usually contrived to be about 0.33.

5. Finally, build in a cover task. Instruct the program to render one of the objects in RED, as opposed to gray. The program will do this about 20 times over the course of a 10-min experiment, selecting the moments randomly. The participant's task will be to press a key whenever an object is shown in gray, but to withhold a response whenever it is red. This will keep them engaged in the stimuli.

3. Familiarity test

1. Write a separate program for the familiarity test. On each trial of the test, the program randomly selects one of the actual triplets, and it randomly generates a new triplet from the constituents of the actual triplets. These randomly generated triplets are called 'foils.'
2. They are displayed side-by side, and the participant needs to indicate which is more familiar by a key press.
3. The experiment should include about 30 familiarity test trials.
4. The instructions for the familiarity test are important. They must include something like this: "I'd like you to do one more task before the experiment is over. It should only take five minutes. You probably did not notice it, but in the sequence of shapes you just saw, some shapes were more likely to appear following others. I'll now show you two sets of shapes from the experiment, and you need to just press the 1-key or the 2-key to let me know which grouping looks more familiar to you. You may not feel that you recognize either. In all trials, I want you to just go with your gut and to guess if you have to."

Results

Because each familiarity test includes one triplet and one foil (a randomly generated non-triplet), chance performance overall is 50%. Score each trial in terms of whether the participant chose the triplet or the foil as more familiar, and selecting triplets more than half of the time constitutes a demonstration of statistical learning. After testing 10-20 participants, average together the rate of choosing the familiar triplet among all the participants. A simple bar graph is a good way to visualize the main effect (**Figure 3**).
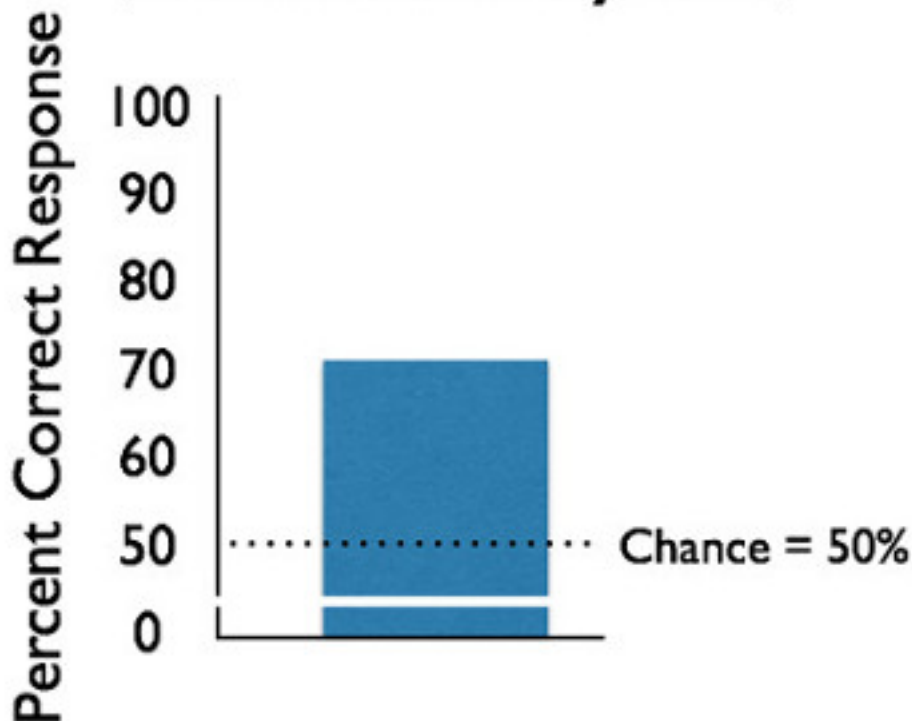

Figure 3. Statistical learning rate as measured by triplet identification in a familiarity test. 50% is chance performance, equal familiarity with both triplets and foils.

Applications and Summary

Visual statistical learning has been utilized as a starting point for investigating a variety of issues in learning, perception, and memory. These include the influence and necessity of attention for learning, the brain areas involved in implicit visual memory and object recognition, as well

as differences and similarities in learning about spatial vs. temporal structure. Visual statistical learning is also thought to be an example of a broader class of statistical learning mechanisms, including auditory statistical, which is thought to support early language learning in infants and children because the sounds and letters in a language tend to appear with highly reliable statistical relationships.