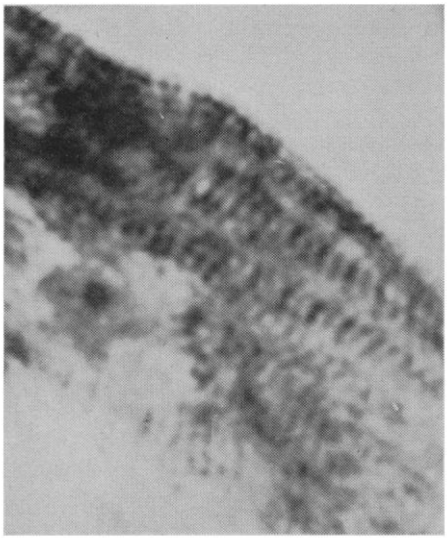

Fig. 1. Bright field photomicrograph of an extracted beating heart cell stained for calcium-activated adenosine triphosphatase activity (× 4000).

rats was cultured in plastic culture dishes as single cells which continue to beat (*5*). After extraction with a glycerol-water solution (*6*), the cells no longer beat spontaneously, but the contractile apparatus is still functional. This preparation is similar to the extracted fibers described by Szent-Györgyi (*7*). Extracted cells were fixed at 0°C for 30 sec with 3 percent formol (*8*), and incubated for 15 min at 37°C in a mixture containing $10^{-3}M$ ATP, $6.7 \times 10^{-3}M$ $CaCl_2$, and $2 \times 10^{-2}M$ sodium barbital at *p*H 9.4. The inorganic phosphate formed at the site of enzyme action was precipitated *in situ*

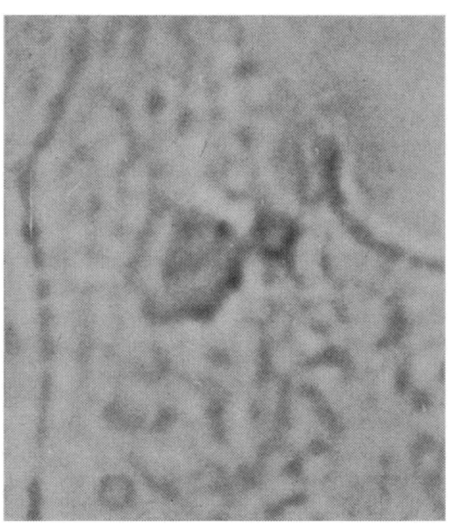

Fig. 2. Bright field photomicrograph of a control cell, which was incubated with inorganic phosphate in place of ATP. Unstained cells are barely visible under bright field conditions (× 4000).

as calcium phosphate. After treatment successively with a soluble cobalt salt and ammonium sulfide the precipitate was converted to a microscopically visible black deposit, CoS. As a control, inorganic phosphate was substituted for ATP in the reaction medium. The result was an almost imperceptible overall graying of the cells with no localization. The cells were mounted wet with polyvinyl pyrrolidine (*9*). This eliminates the need for clearing and dehydration and permits the use of plastic culture dishes which would dissolve in clearing solutions.

Figure 1 is a photomicrograph of a preparation of a heart cell preparation grown in culture for 2 days. This cell has been stained for the calcium-activated enzyme and the blackened areas indicate the site of action. Of particular interest are the striations which indicate that this activity is discontinuously distributed along the myocardial fibril. Figure 2 is a photomicrograph of a control cell which was incubated with inorganic phosphate instead of ATP. The cell is barely visible and no localized staining occurs. The calcium-activated adenosine triphosphatase activity of isolated myosin suggests that the activity in the myofibril may be associated with myosin, and that the heavily stained band corresponds to the A band while the unstained area corresponds to the I band (*10*). It is not clear whether the alternating, more lightly stained bands are indicative of myosin at a region corresponding to the Z line or of some other calcium-activated adenosine triphosphatase in the sarcomere. During the course of our work a similar observation has been reported (*11*). The excellent electronmicrographs demonstrate that the enzyme is localized only in the A band. This may be further studied with the use of fluorescein myosin antibodies (*12*) in conjunction with enzymatic localization (*13*).

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Language and Thinking: Positive and Negative Effects of Naming

Abstract. *Subjects instructed to think of novel shapes in terms of relevant names made fewer errors in recalling a serial ordering of the shapes, but more errors in solving a mental jigsaw puzzle and in drawing the shapes from memory, than subjects instructed to visualize the shapes without using words.*

Is it easier to think about objects, and to manipulate them "in one's head," if one has names for them than if one does not? Spiker (*1*) found that performance in the delayed-reaction experiment, often considered to depend on representational processes, was facilitated when subjects had names for the stimuli. He suggests that during the delay period the subject repeats the name of the baited stimulus, and that the name then serves to guide his choice. This hypothesis assumes that names do in fact perform this representational function more effectively than nonverbal representations, such as images. On the other hand, Saltz and Newman (*2*) found that while learning the names of the parts to a low criterion before doing a mechanical assembly problem led to fewer errors, learning to a high criterion resulted in more errors than no name learning at all. Thus names yielded no consistent advantage in the kind of mental manipulation required in the assembly problem. These findings suggest that the effect of prior name learning on thinking depends on the nature of the problem. Pretraining which leads a subject to think of objects in terms of names, rather than, say, in terms of images, may facilitate performance in one problem but interfere with performance in another.

The relative effectiveness of nominal (verbal) and imaginal representations will presumably depend, among other things, on the kind of information about the stimulus objects which is needed to solve the problem. The evidence from the delayed-reaction experiments and from studies of the effect of name learning on serial learning (*3*) suggests that names will be advantageous when the task involves short-term retention of specific items or of sequences of items, as do many reasoning tasks. If, on the other hand, problem solution specifically depends on figural properties of the stimuli (as opposed to such properties as weight, number, or sequence), as is true in the mechanical assembly problem, we might expect imaginal representations to be at least as effective as names. If, as seems likely in view of the effect of labels on reproduction of visual forms (*4*), introduction of names results in loss or distortion of figural information, the imaginal representations should be more effective in such problems. Such a finding would be contrary to Prentice's conclusion (*5*) that names do not affect what is remembered but only the way it is reproduced.

Two groups of 16 undergraduates each, the "Named" and "Unnamed" groups, were given training designed to induce the formation of, respectively, nominal and imaginal representations of a set of novel shapes. Half the subjects in each group then attempted to solve, in their heads, a "mental jigsaw puzzle" composed of the shapes. The other half of each group were given a memory task in which they had to reconstruct, in their heads, a novel ordering of the shapes, after seeing the novel ordering only once. The jigsaw puzzle could be solved only if the subject's representation of the shapes encoded their figural properties. The memory task provided a direct measure of short-term retention of sequences at the ideational level.

The stimulus objects were eight shapes, each consisting of a 2-inch square with the top and bottom sides replaced by randomly constructed three-segment contours. Four such contours were used, each appearing as the top of two shapes and the bottom of two others (Fig. 1). Starting from any shape, the eight shapes could be fitted together in several different ways, one under the other in jigsaw-puzzle fashion, to form a vertical column. Subjects were first shown each shape for 30 seconds. Those in the Named condition were given an animal name for

Table 1. Errors and logarithmic solution times.

Condition	Errors		Log *t* (sec)	
	Mean	σ	Mean	σ
	Jigsaw problem			
Named	4.9	1.5	2.52	0.24
Unnamed	2.6	1.6	2.54	0.29
	Memory task			
Named	2.5	1.6	1.45	0.18
Unnamed	4.6	1.2	1.66	0.30

each shape (Fig. 1), and the way in which the shape resembled the named animal was pointed out to them. Subjects in the Unnamed condition were instructed "to study each shape carefully . . . and try to remember what it looks like," but "to think of each shape just as a shape, without using words in any way."

All subjects then received training in a recognition task, designed to provide an opportunity for subjects in the Named condition to practice naming the shapes, while requiring subjects in the Unnamed condition to attain the same degree of proficiency in discriminating the shapes, without using words. A test shape was shown for 2 seconds and then, after a 2-second pause, all the shapes were presented, and the subject pointed to the test shape. In the Named condition, subjects, prompted by the experimenter if necessary, said the name of the test shape when it was first shown on each trial, and were instructed to "try to remember the shape by keeping the name in mind." In the Unnamed condition, subjects were told to "try to remember the shapes by visualizing them to yourself, without using words." Subjects in both Named and Unnamed conditions continued recognition training until they had given correct recognitions for all eight shapes on four consecutive trials. Accuracy of naming the shapes did not enter into this criterion. The shapes were so con-

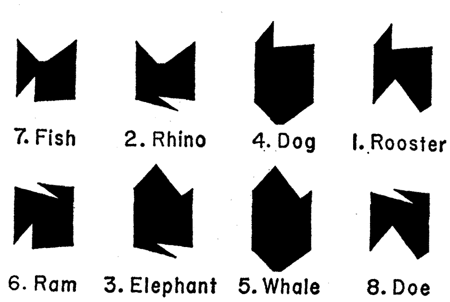

Fig. 1. Stimulus shapes, with names, grouped vertically by bottom contour and horizontally by top contour. Numbers indicate position in ring, running clockwise, with No. 8 at the top.

structed that the subject had to use information from both top and bottom contours of each shape to respond successfully in the recognition task, whether he was in the Named or Unnamed condition. In this sense, the cues used to discriminate the shapes, and the level of discriminative ability represented by the recognition criterion, were the same in the two conditions.

All subjects next learned to associate each shape with a different position in a ring consisting of eight small circles arranged to form a large circle. After a demonstration trial, the experimenter pointed to the positions in random order, and the subject pointed to the shape which belonged in each position. Training continued to a criterion of four consecutive perfect trials. Instructions concerning the use of names were similar to those in recognition training. [A more detailed description of these training procedures is given elsewhere (*3*, "experiment IV").]

In the jigsaw problem, the experimenter indicated the shape, randomly assigned, from which the puzzle was to start. The subject's task was to pick another shape that would fit under the first one (that is, one whose top contour would match the bottom contour of the first shape), then a third shape which fitted under the second, and so on. The subject did not see the shapes at any time during the problem. The starting shape, and the subject's subsequent choices, were indicated by referring to the corresponding positions in the blank ring, and numbering them to indicate the order in which the shapes should be arranged to form the jigsaw column. An error was scored for each instance in which two nonmatching contours were placed adjacent to one another in the subject's final ordering of the shapes.

In the memory task, the shapes were shown one at a time for 2 seconds each, in a random order, different for each subject. A test for recall of this new order followed immediately. As in the jigsaw problem, the experimenter indicated the first shape, and the subject indicated his choices, by numbering the corresponding positions on the blank ring. An error was scored for each incorrect two-shape sequence in the final ordering. Nothing was said about the use of names in the presentation of either problem.

Mean errors and mean logarithmic solution times are shown in Table 1. Subjects in the Named condition made fewer errors on the memory task, but more errors on the jigsaw problem, than those in the Unnamed condition. This interaction between effect of names and type of problem is highly reliable (2×2 analysis of variance, $F = 15.19$, $df = 1/28$, $p < .001$). The Named-Unnamed difference is reliable both on the jigsaw problem (overall within-groups mean square used as error estimate, $t = 2.91$, $df = 28$, $p < .01$) and, in the opposite direction, on the memory task ($t = -2.66$, $p < .05$). The only reliable effect on solution times is the overall difference between jigsaw and order problems ($F = 100.17$, $df = 1/28$, $p < .001$). The fact that solution time for the jigsaw problem was slightly longer for the Unnamed than for the Named group raises the question whether the Unnamed group made fewer errors simply because they spent more time on the problem. When the effect of this difference in working time is removed by means of covariance analysis, however, there is still a reliable difference in errors in favor of the Unnamed condition ($F = 7.62$, $df = 1/27$, $p < .05$).

The assumption that the Unnamed group would form representations which encoded more information about figural properties of the shapes than the representations used by the Named group was tested directly by having all subjects draw the shapes from memory, in their positions in the ring, at the end of the experiment. An error was scored for each of the eight line segments of each shape that was omitted, drawn slanting in the wrong direction, or connected to the wrong end of an adjacent segment. The mean number of such errors was 20.2 in the Named condition and 14.8 in the Unnamed condition ($t = 3.10$, $df = 30$, $p < .01$).

The results are consistent with the assumption that the Named and Unnamed conditions induced the formation of verbal and imaginal representations, whose relative merits depend on the problem to be solved. An alternative possibility is that subjects in the Unnamed condition verbalized the figural properties of the shapes, or the relations between them, and that these verbalizations facilitated the jigsaw and drawing tasks. Analysis of post-experimental reports does not support this interpretation. Those subjects in the Unnamed condition who reported doing the most verbalizing made more errors in the jigsaw problem and fewer in the memory task than those reporting less verbalizing. Subjects who reported that they did not notice during training that any of the shapes fitted together showed as strong an interaction between naming and type of problem as those who reported noticing such relations. These findings support the interpretation that the interaction reflects a difference in the properties of nominal and imaginal representations (*6*).

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1 April 1963

Underwater Sounds of Pinnipeds

Abstract. *Descriptions and analyses are presented of underwater sounds made by six species of seals in captivity,* Zalophus californianus, Phoca vitulina, P. (Pusa) hispida, P. (Pagophilus) groenlandica, Halichoerus grypus, *and* Cystophora cristata. *The suitability of these very faint sounds for echolocation is discussed.*

Many observers of seals have felt, from the success of these animals at making a living in dark and turbid waters, that acoustics must play an important part in their lives. From Scheffer's recent review of the pinnipeds (*1*) we learn that their olfactory apparatus is reduced (no great loss to a submerged air-breather), that not much is known of their hearing, and that while the eyes are normally well-developed and adapted to water and darkness, "individuals totally blind but in good health have been reported." This certainly suggests at least expert passive use of sound (listening), if not active use (echolocation). For a long time no underwater sounds were detected, although a number of people listened for them (of course, the familiar raucous above-surface calls, particularly of the otariids, have often been heard underwater). Thomas C. Poulter was the first to record underwater calls of pinnipeds. He described pulsed signals of captive *Zalophus californianus* and mentioned similar sounds of two or three other otariids and two phocids (*2*). In the meantime one of us (C.R.) had been eager to test his long-standing feeling that seals must use active underwater sound, and had arranged for us to investigate the seals exhibited by the New York Zoological Society at their Aquarium and Zoological Park. This we did in January 1963, listening and recording in the presence of three species of otariids, *Zoalophus californianus, Eumetopias jubata*, and *Callorhinus ursinus*, a walrus (*Odobenus rosmarus*), and five species of phocids, *Phoca vitulina, P. (Pusa) hispida, P. (Pagophilus) groenlandica, Halichoerus grypus*, and *Cystophora cristata*. We were unable to attribute exclusively underwater sounds with certainty to *Eumetopias, Callorhinus*, or *Odobenus*. It was soon apparent why we had failed to hear seals in the field. The only underwater sounds which we now heard were impulses (or clicks) so faint that they were not detected unless the seal was within about 3 meters of the hydrophone. In this and other ways they differed from

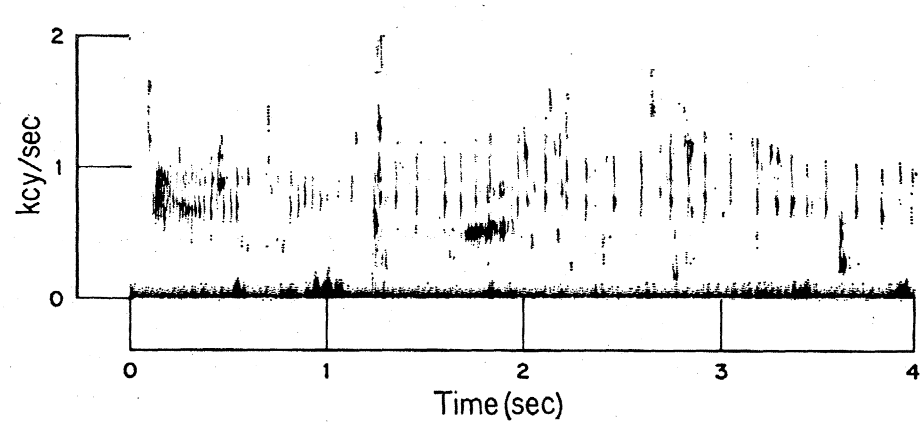

Fig. 1. Underwater clicks of a *Zalophus californianus* searching the bottom of its pool at the feeding station; 100-cy/sec bandwidth analyzing filter. (A 300-cy/sec high-pass filter reduced some of the tank background.)