Commentary

Latent learning does not produce instantaneous transfer of place navigation: A rejoinder to Keith and McVety

G. L. CHEW, R. J. SUTHERLAND, and I. Q. WHISHAW
University of Lethbridge, Lethbridge, Alberta, Canada

A recent paper by Keith and McVety (1988) examined latent place learning by rats in a novel environment using the water task developed by Morris (1981). Their results supported those of previous studies that showed that rats make use of latently learned spatial information, acquired while sampling environmental cues from the vantage point of an escape platform (Sutherland & Dyck, 1984; Sutherland & Linggard, 1982). A nice feature of Keith and McVety's method is that if rats master all of the procedural aspects of the water task in one room, the magnitude of the latent learning effect in a novel room is greater than the latent learning effect found by Sutherland and Linggard. Keith and McVety concluded that their animals were able to navigate accurately on the first trial after viewing the novel room from the hidden platform. This view is consistent with the instantaneous transfer concept of Morris.

Furthermore, Keith and McVety (1988) suggested that their findings were in sharp contrast to those of Sutherland, Chew, Baker, and Linggard (1987) who, according to Keith and McVety, presented evidence that "weighs heavily against the notion of instantaneous transfer" (Keith & McVety, 1988, p. 146). Keith and McVety also asserted that their own "latent learners" generated accurate trajectories to the goal, and inferred that "the knowledge system that subserves place learning is independent of the behavioral actions the animal must initiate to navigate to the platform" (Keith & McVety, 1988, p. 150).

We feel obliged to respond to Keith and McVety, not only because they have inaccurately portrayed the viewpoint presented by Sutherland et al. (1987), but also because they have overinterpreted their own findings. We hope to reconcile both wrongs and, in so doing, arrive at a single, coherent conceptualization of latent place learning in rats.

The Nature of Accurate Navigation and Instantaneous Transfer

At the outset, we must make clear what we mean by accurate navigation from a novel location. This, quite sim-

ply, is the unswerving trajectory of an animal from a start location to a goal platform in minimum time (Figure 1A). With the apparatus of Sutherland et al. (1987), accurate navigation by rats is a straight line from start to goal lasting about 4 sec. This is also true for the Keith and McVety (1988) rats, which were trained and tested in pools of comparable dimensions (Keith & McVety, 1988, Figure 2).

Instantaneous transfer, a theoretical consequence of the O'Keefe and Nadel (1978) spatial mapping hypothesis, is denoted by accurate navigation from a novel rather than from a familiar location. A meandering trajectory, with a resultant longer latency, is not indicative of accurate navigation (Figure 1B).

Given this distinction, our first point is that Sutherland et al. (1987) did not dispute the existence of instantaneous transfer; rather, they qualified when it could be achieved. According to Sutherland et al., only when an animal has sampled the distal cues from the vicinity of a novel location and has swum through that region on its way to the hidden platform can it produce a straight trajectory in minimum time from the novel start location to the goal platform. Accurate trajectories may be generated from

Figure 1. Representative trajectories of rats in the Morris (1981) water navigation task. (A) An accurate trajectory of 4 sec duration. (B) A typical trajectory of 11 sec duration by a rat yet to master the task.

Correspondence may be addressed to G. L. Chew, Department of Psychology, University of Lethbridge, Lethbridge, Alberta T1K 3M4, Canada.

locations that are novel in the task *sensu strictu* but are not novel in the experience of the animal.

Keith and McVety (1988) are reluctant to accept these conditions limiting the capacity for latent place learning. They argue that cue sampling from the goal location is sufficient for rats to generate accurate navigation from any point in the environment, provided the rat has mastered the procedural aspects of the water task. They cite as evidence their latent learners, which viewed a novel room from a platform. These animals, they claim, generated accurate trajectories (evaluated using latency scores) to the platform without any of the visual or motor experience the Sutherland et al. (1987) thesis necessitates. Unfortunately, the latencies of Keith and McVety's latently trained "accurate navigators" were two to three times longer than would be expected for accurate navigators swimming in familiar surroundings. This apparent paradox is what we call the *increased latency problem*.

It is unlikely that this problem is the result of peculiarities of the pool used by Keith and McVety (1988). Sutherland and Rudy (1988) had accurate navigators of the standard 4-sec straight-line variety using the same apparatus. Perhaps the Keith and McVety rats just swam slowly. But why should rats swim faster in a familiar setting and slower in the novel one if they are presumed to be equally adept? What were the rats doing when they were taking such a leisurely approach? Keith and McVety did not provide any data that might resolve the increased latency problem.

Given that the Keith and McVety (1988) rats were of the same strain as those used by Sutherland et al. (1987) and were tested in comparable (sometimes identical) facilities, only one explanation for the increased latency problem seems reasonable. That is, the performances of Keith and McVety's latent learners simply were not as good as they would have been had they actually swum through the region of the start location. In fact, the 11-sec escape latency shown by the latent learners is about the same as that of rats denied access to half of the test pool by a clear partition (Sutherland et al., 1987; see Group C, Figure 2). Curiously, Keith and McVety claimed those animals "navigated poorly" on the transfer test because "Sutherland et al.'s methodology obscured the spatial cognitive capacities of their subjects" (Keith & McVety, 1988, p. 151), whereas their own rats navigated accurately using the same criterion. The authors cannot have it both ways.

We offer an alternate interpretation, consistent with data from both laboratories, that latent learners show accurate instantaneous transfer to a novel start location only if they have previously sampled a subset of trajectories through the general vicinity of the start site on their way to the hidden platform.

In support of this view, as well as to resolve the increased latency problem, we present evidence from an experiment independent of, but comparable to, those of Keith and McVety (1988) and Sutherland et al. (1987). Two groups of rats were trained in the water task with the hidden platform moved to a new location each day.

Animals of the first group (View group) were placed singly on the escape platform in its new location for 30 sec prior to swim training each day. In contrast, a second group (No View group) was not given an opportunity to view the room from the novel platform location before swim training. On the first test trial, the No View group took significantly longer to reach the platform than did the View group. The performance of the View and No View groups was quantitatively similar to Keith and McVety's V-V and V-NV groups, respectively. That is, their rats were also slower to reach the platform than were the truly accurate navigators, but were faster than rats that did not view the room from the platform.

However, additional swim trials for the View and No View rats in the same session (i.e., after the opportunity to swim in the pool) showed that both groups produced significantly shorter latencies on the very next trial (Figure 2, top). Even when the procedure was repeated for 8 consecutive days, the number of correct (i.e., unerring) trajectories jumped dramatically after the initial swim trial within a given session (Figure 2, bottom).

Figure 2. Top—Latency to reach the goal on two successive trials. In both the View and No View groups, the latency was shortened on the second trial. Bottom—Number of correct responses (i.e., unerring trajectories) to reach the goal averaged over eight consecutive daily sessions. In both the View and No View groups, the mean number of correct responses increased on the second trial within a session.

Thus, rats swam faster, straighter, shorter routes to the goal more often when they were given an opportunity to swim, even after they had mastered the procedural aspects of the task.

Hence, the View rats took longer to find the platform on the first test trial than on the second trial because they did not compute an accurate trajectory based solely on their previous placement on the platform: there was no instantaneous transfer. Only with the visual and motor experience provided by the opportunity to swim in the novel room did the rats navigate directly to the platform.

This finding may also explain the increased latency problem in the Keith and McVety (1988) study. In confusing *improved* performance with *accurate* performance, Keith and McVety did not find instantaneous transfer; rather they demonstrated that their latent learners showed better performance if they had viewed the room from the platform than if they had not done so.

We conclude, as Keith and McVety (1988) did, that preexposure to the room cues from the vantage point of a goal platform improved the rats' performance on subsequent test trials. We further conclude that additional experience swimming in the pool was necessary for the acquisition of accurate place navigation. Keith and McVety did not sufficiently address the question of instantaneous transfer because they did not test their animals in the novel location more than once.

In summary, Keith and McVety (1988) have not refuted a theoretical position, erroneously attributed to Sutherland et al. (1987), that argues against the possibility of instantaneous transfer of navigation. Instead, they have provided a confirmation of latent place learning in the Morris (1981) water task using a procedure superior to

previous approaches, and have provided further experimental support for the view that rats navigate more accurately in surroundings they have explored than in those to which they have had limited or no exposure at all.

Given the outcome of these experiments, we hold that the neural system that subserves truly knowledgeable navigation is intimately acquainted with the detailed information from experienced local views and routes (see also McNaughton, 1989).

REFERENCES

- KEITH, J. R., & MCVETY, K. M. (1988). Latent place learning in a novel environment and the influences of prior training in rats. *Psychobiology*, **16**, 146-151.
- MCNAUGHTON, B. L. (1989). Neuronal mechanisms for spatial computation and information storage. In L. Nadel, L. Cooper, P. Culicover, & R. M. Harnish (Eds.), *Neural connections and mental computations* (pp. 285-350). Cambridge, MA: MIT Press.
- MORRIS, R. G. M. (1981). Spatial localization does not require the presence of local cues. *Learning & Motivation*, **12**, 239-260.
- O'KEEFE, J., & NADEL, L. (1978). *The hippocampus as a cognitive map*. Oxford: Oxford University Press.
- SUTHERLAND, R. J., CHEW, G. L., BAKER, J. C., & LINGGARD, R. C. (1987). Some limitations on the use of distal cues in place navigation by rats. *Psychobiology*, **15**, 48-57.
- SUTHERLAND, R. J., & DYCK, R. J. (1984). Place navigation by rats in a swimming pool. *Canadian Journal of Psychology*, **38**, 322-347.
- SUTHERLAND, R. J., & LINGGARD, R. (1982). Being there: A novel demonstration of latent spatial learning in the rat. *Behavioral & Neural Biology*, **36**, 103-107.
- SUTHERLAND, R. J., & RUDY, J. W. (1988). Place learning in the Morris place navigation task is impaired by damage to the hippocampal formation even if the temporal demands are reduced. *Psychobiology*, **16**, 157-163.

(Manuscript received October 12, 1988;
revision accepted for publication January 18, 1989.)