

TOLMAN AND HONZIK (1930) REVISITED OR THE MAZES OF PSYCHOLOGY (1930-1980)

FRANCINE CIANCIA

Université des Sciences et Techniques de Lille Flandres-Artois

After its description by Tolman and Honzik in 1930 under the title "'Insight' in rats," the sudden adjustment of some rats to a new maze setup had been ascribed to perception and mnemonization, to consciousness and inventive ideation to reasoning or, again, to inferential expectation. In 1948, inventing the cognitive map, Tolman did not refer to this behavior "to lend further support to the doctrine of building up of maps" (Tolman, 1948, p. 200). Nevertheless, psychologists have not ceased to fit it to that famous Tolmanian concept.

As I first read some of the criticism of Tolman's (1886-1959) experimental and theoretical work, the article "'Insight' in Rats," which he wrote in conjunction with Honzik in 1930, immediately appeared quite remarkable to me, for two reasons. On the one hand, it has remained a work of reference for 50 years; while on the other, paradoxically, an investigator without ready access to the original work might still find its content ambiguous. So it is that psychologists referring to this work disagree on the number of rats that were trained in a maze, the type of which, not to mention all its characteristics, is sometimes even impossible to define accurately from the original article.

Quite apart from the multiple interpretations of this singular experiment produced by Tolman and Honzik in 1930 (TH, for short), that unusual disparity in numbers and the understated descriptions of the experimental device were what really prompted me to read TH in the original. There, I discovered an experimental report deserving of careful commentary and realized that its exemplary history contained, at one and the same time, the discursive variations of an honest experimentalist before the objects he observes and creates and the limitations these objects finally impose on his fancy talk.

“Insight’ in Rats” Revised and Corrected: 1932-1980

I begin by examining those accounts of the facts given by some exponents, including Tolman, which made me wish to obtain the 18 pages published in 1930.

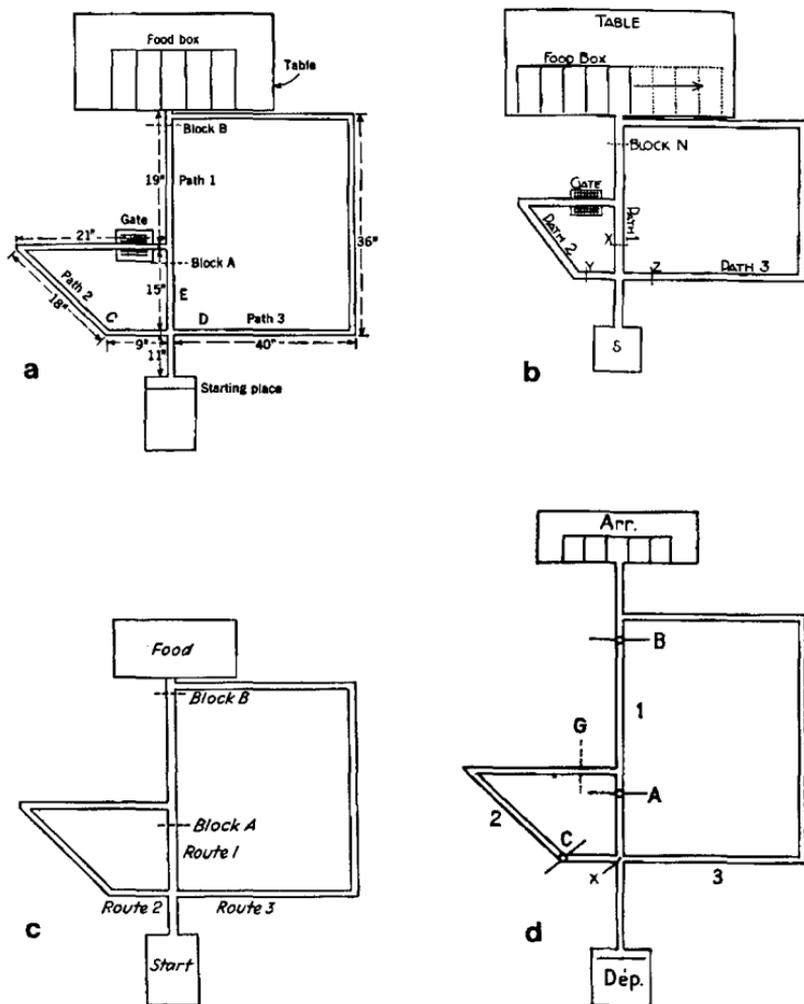


Figure 1. Mazes used by or imputed to Tolman and Honzik (1930).

(a) This maze, published by Tolman and Honzik (1930, p. 223), Tolman (1932, p. 167), and Keller and Hill (1936, p. 485) is reproduced from Munn (1950, p. 271). At E, C, and D, blocks could be either placed to prevent entrance upon the corresponding paths or removed to permit it. Hilgard and Bower (1975, p. 133) published a similar diagram but put D closer to the intersection of Paths 1, 2, and 3 and omitted the dimensions.

(b) Maze published by Tolman (1933, reprint in Tolman, 1966, p. 74).

(c) Maze published by Maier and Schneirla (1964, p. 467). C, E, D, and the gate have disappeared. The maze published by Bolles (1975, p. 81) is just as bare as this one.

(d) Maze published by Gréco (1969, p. 176). X merely marks the intersection of Paths 1, 2, and 3. For Gréco “G” does not stand for “Gate” but “Grate” [my translation].

All the various phases of the TH experiment are often briefly reported but in the main, the following description is kept in mind. The starting place in a maze (see Figure 1a) opens onto three paths of different lengths leading to a food box. The shortest path (P1) and the intermediary one (P2) share a common final section ending at the food. The long path (P3) also finishes at the appetitive stimulus but has no section in common with the two other paths. Setting out from the starting box, the hungry rat henceforth takes the short path. When P1 is blocked at A within its own section by a barrier the rat turns back to run, in most cases, along P2. He rarely uses P3. Under these conditions, what does the animal do if the section common to P1 and P2 is blocked at B? He retraces from the obstacle and immediately takes the long path, the only one still open in the direction of the reinforcing stimulus.

In *Principles in Animal Psychology*, which originally appeared in 1935 and more precisely, in that part of their work called "Reasoning in Maze Situations," Maier and Schneirla (1964) maintained that the rats used by TH entered the long path straight after the first block on the section common to the two other paths. These writers did not say whether the device was enclosed or elevated. After they had presented the TH experiment under "Place Learning" Hilgard and Bower (1975) put forward, as did Bolles (1975), the term of map to interpret the TH results. Neither the first two authors nor the third one mentioned the maze type.

Yet, 25 years earlier, in his *Handbook of Psychological Research on the Rat*, Munn (1950) noted: "Tolman and Honzik (1930) repeated Hsiao's experiment under somewhat different conditions *but they found no evidence of insight* [italics added]" (p. 271). On the subject of the same publication, he added: "in another experiment with *the elevated maze* [italics added] . . . some rats adjusted suddenly, thus seeming to justify the inference that insight had occurred" (p. 271). And finally he pointed out that in this elevated maze "the rat's behavior could be interpreted as responding in terms of stimuli, all of which were present at the time of response" (p. 272).

Keller and Hill (1936) emphasized that TH themselves attributed the findings "*in the third experiment*" [italics added] to the fact that the maze was elevated. Similarly, in 1954, Caldwell and Jones stated that "in the *third* [italics added] experiment the animal might see the whole experiment, thus placing the results within the area of perception rather than "insight" (p. 416).

Now, although Gréco (1969) and Vauclair (1980) noted alike that TH tested the rats in an elevated maze, the first author chose to describe the TH investigation under the heading "Inferential Anticipation [my translation]" (p. 175) and the second one observed that "for Tolman, *insight* presupposed the intervention of an internal, inferential process of elaboration [my translation]" (p. 348).

In *Purposive Behavior in Animals and Men*, as early as 1932, Tolman was explicit: The rats showed insight, not in the two enclosed mazes that TH also used, but in a third one that was "constructed of

one-inch laths, i.e., without sides" (p. 167). However, one has to consult this subsequently famous work to see that Tolman (1932) himself substantiated several views of TH's unique experiment. The first time he mentioned it, under "Inferential Expectation based on Perception," he explained:

It appears probable . . . that the positive results . . . obtained with the elevated maze were, in at least some degree, favored by the fact that in this latter maze *mnemonization*¹ could be eked by *perception*. Expectation of the commonness of a final segment is easier for perception plus mnemonization than for mnemonization alone. (p. 170)

The second time Tolman (1932) mentioned this experiment, in chapter 14 on "Inventive Ideation," he suggested that it could be "illustrative also of *inventive ideation*[s]" (pp. 231-232) and concluded: "It may be, in short, that all 'inferential' sign-gestalt-expectations are always evidence of some degree of consciousness and inventive ideation" (p. 232). Now, it may be useful to point out that Tolman (1932) provided a glossary at the end of his book, in which "inferential expectation" was "the same as inference" (p. 446). Similarly, "inference" is given first as: "one of the three moods of sign-gestalt expectation. . . . The other two moods are perception . . . and mnemonization" (p. 446), then a little farther on, under the same entry: "Inventive ideation . . . is to be conceived as a special, sophisticated, and recondite form of inference as just defined" (p. 446). Furthermore "insight" was thus defined: "The term *insight learning* has often been used to designate that process which we have called *inventive ideation*" (p. 447).

In the third experiment conducted by TH, Maier and Schneirla counted 25 animals whereas both Gréco and Vauclair put their number at 15. Referring to a diagram matching the one reproduced in Figure 1a, Tolman (1932), like those authors, first asserted that "during the *preliminary training*, Path 1 was blocked at A . . . in the final test, the block was placed in the common section of Paths 1 and 2 (Block B)" (p. 168). However, he then specified: "Two groups of rats were tested in this fashion. We may consider the results for each group separately" (p. 168). Finally, having given the results for Group A which consisted of 15 rats, he added the following footnote:

¹ In his glossary, Tolman (1932) made a distinction between mnemonization and memory. Under "mnemonization" he wrote:

In mnemonization, stimuli for the sign-object only are present, but the stimuli for the signified-object, or the signified means-end-relation, the mnemonization for which is under consideration, have as such been specifically present one or more times in the past. (p. 452)

For Tolman (1932) memory was "the name for that special limited variety of mnemonization in which the signified means-end-relation contains a dating of the signified object as temporally past" (p. 452).

A possible criticism is to be raised against the results of this group in that *during the course of the training they were each given twelve special runs of a somewhat similar sort to the test run* [italics added]. In these special runs the animals were blocked *in the common segment at A when they had entered Path 1* [italics added]. On returning out of Path 1, they could then take either Path 2 or Path 3. This may be considered as of the nature of final training for the test run. And it was in order to obviate this criticism that the next group was run. (Tolman, 1932, p. 169)

The first sentence of this footnote makes it clear that Group A differs from Group B; but the rest, in not tying in with what Tolman (1932) wrote on the previous page, that is, "in the final test, the block was placed in the common section of Paths 1 and 2 (Block B)" (p. 168), could explain the authors' discrepancies with regard to the number of rats. Be that as it may, there is nothing, as we shall see before long, in the original account of this third experiment to reconcile Tolman's (1932) text with his (1932) footnote. However, the first two experiments and their enclosed mazes do, on examination, make it clear that Tolman (1932) was mistaken: Only that first sentence of the footnote applies to Group A of Experiment III. Those that follow describe the test runs—the insight runs—which the rats in Experiments I and II made in enclosed mazes. In these mazes, a swinging door marked on the diagrams with the letter A was locked "at the end of the common section to paths 1 and 2" (Tolman & Honzik, 1930, p. 217; see also pp. 216 and 221). Tolman's (1932) mistake is all the more perplexing in having slipped into a footnote where we rightly expect to find additional relevant information.

Comparing the iconography relating to the TH experiment brings its own surprises too. Indeed, Keller and Hill (1936), Munn (1950), and Tolman (1932) presented with their commentaries a diagram (see Figure 1a) reproduced from Tolman and Honzik (1930) which contained elements not found on that used by other authors to illustrate their commentaries. One example will suffice: The gate placed on Path 2 (see Figure 1a) disappeared from Maier and Schneirla's diagram (see Figure 1c) and became a "grate" [my translation] on Gréco's (1969, p. 176) (see Figure 1d). Such trimming and transforming could be attributed to praiseworthy simplification were we to forget Tolman's (1932) footnote:

The place labeled 'gate' was a tunnel with a permanent gate which allowed the rats to pass from Path 2 to the common final section of Path 1, but prevented retracing Path 1 into Path 2. (p. 162)

Or were we to ignore Dove and Thompson's (1943) explanations:

Being unable to transverse Path 2 because of the gate the animal had to back out on Path 1 again . . . where he turned left on Path 3 since he had already been blocked when trying to turn right previously. (p. 239)

“Insight’ in Rats” When It Appeared: 1930

It is now deemed necessary to read the original publication.

Under the title “‘Insight’ in Rats,” there were indeed three experiments. In the first two, TH did indeed use enclosed mazes. A new elevated maze was built for Experiment III and verification shows that the diagram of this maze is identical to the diagram published in Tolman (1932) (see Figure 1a). The gate placed on Path 2 prevented return by way of this path. This gate was made “with mesh hardware cloth” (Tolman & Honzik, 1930, p. 216) (could this explain Gréco’s grate?). Having abandoned the enclosed mazes with which they had failed to show that “a rat can get the ‘insight’ that two paths have a common section” (Tolman & Honzik, 1930, p. 215), Tolman and Honzik (1930) ran their animals along “rails or runways 1.5 inches wide” [which were] “30 inches above the floor” (p. 222). They put 15 rats (Group A) through a preliminary training period lasting 13 days with a final test period on the 14th day which consisted of 7 insight runs during which one block was at B. The twelve runs of the first training day were free. At the close of this day, the writers found that Path 1 was the path most often taken; so, from the second day on, in 10 out of 12 runs, they blocked this path by placing, at A, one of the wire-netting blocks “used to prevent entrance upon any path” (p. 222). The rat then, no longer entered Path 1 but took immediately either Path 2 or Path 3. Such behavior jeopardized the final test, where the animal had to enter Path 1 before encountering the block at B on the section common to Paths 1 and 2. So, TH substituted the wire-netting block at A, on the fourth day, with “one made of a piece of clear window glass”² (p. 224). But, as “this method was effective for a time but again the rats learned to see the glass and not to approach it” (Tolman & Honzik, 1930, p. 224), a new procedure was put into operation and without saying on which day it began, TH described it in these terms:

As a last resort, rats that did not approach the block at A voluntarily were forced to do so by blocks placed at C and D [see Figure 1a]. Finding paths 2 and 3 blocked the rat ran to block A. The blocks at C and D were then quickly and quietly removed while he was still facing toward block A, and on his return he chose either Path 2 or Path 3. (p. 224)

Obviously that first phase of preliminary training, which lasted 8 days with 12 runs a day, attracts a lot of criticism regarding methodology but it is as nothing compared to the number of objections the next phase raises.

We will now read the account of this part of Experiment III (Group A), “Days 9-13 (twelve runs a day)” (Tolman & Honzik, 1930, p. 224) which, it may be recalled, preceded the insight runs of Day 14.

²Only Block A was replaced by “one made of a piece of clear window.” At B, the block remained “a wire-netting” one.

On the ninth day of the training period a new type of run was introduced. This consisted of moving the block A on Path 1 forward from the point A to the point E, [see figure 1a] and *setting up also block B* [italics added]. With this arrangement the rats ran to the block at E, had to retrace and then choose Path 2 or Path 3. *If Path 2 was chosen the rat found himself blocked again at B* [italics added]. To permit him to return to the starting point again the block at E was quietly removed while facing block B. Having returned to the starting point the rat could then take Path 3 or blunder into Path 2 by way of which he had just found himself blocked. *It is interesting to note that the first time this type of run was given all the 15 rats chose Path 3 on the second return to the starting point; and thereafter very few mistakes of taking Path 2 a second time were made* [italics added]. (Tolman & Honzik, 1930, pp. 224-225)

Because “the defect inherent in this sort of run is obvious” (Tolman & Honzik, 1930, p. 225) and because “it is very much like the ‘insight’ run which was to follow later and may be considered direct training for later run” (Tolman & Honzik, 1930, p. 225), TH downplayed the significance of this new type of run with the following:

It is therefore important to emphasize that each rat had only 12 runs of this sort, that these runs were distributed over 5 days (average of 2 a day), and that runs were interspersed among 65 other runs which each rat had during these days. The fact that the runs were few in number and were scattered among other runs led the experimenter to believe that their training effect could not be great. *Further, it should be noted that block B, on this run, is encountered not by way of Path 1 (as in the ‘insight’ run) but by way of Path 2* [italics added]. (p. 225)

If these arguments astonish, rereading the ensuing justification still gives rise to the same profound amazement as was first felt:

The advantage of this run and the only reason for its introduction is this: *If the rat had never before encountered the block at B, his first encounter with it in the test or ‘insight’ run might conceivably cause considerable confusion, a factor we wished to minimize. Therefore, some acquaintance with block B was thought advisable, not by way of Path 1 but by way of Path 2, as just said* [italics added]. (Tolman & Honzik, 1930, p. 225)

It is of comparative interest to point out, in passing, that three years later, Tolman was to conclude the version of the third experiment adjusted notably to and described under the title “Sign-Gestalt or Conditioned Reflex,” with:

In other words, it appears that the negative-evolving character of *N* [Figure 1b] was carried back not only to the stimuli at the

entrance to path which stimuli had actually just preceded it but *to the stimuli at the entrance to path 2, which stimuli had never thus preceded N* [italics added]. (Tolman, 1933, reprint in Tolman, 1966, p. 75)

Tolman (1933) completely forgot those twelve special runs which, as noted, he had already failed to describe correctly in 1932. "There were also 171 'forced' runs over Path 3, paths 1 and 2 being blocked" (Tolman & Honzik, 1930, p. 226). It was only at the end of the paragraph "Results of training period" where, it cannot be overemphasized, only results were expected, that TH gave this important information. Yet, all that can be learned about these forced runs is contained in this short sentence. It is therefore impossible to know whether they took place at the onset of the preliminary training period, in the middle, or again at the end of this experimental phase just prior to insight day.

It was only in 1933 that Tolman described these runs in detail:

In the preliminary training the rats were forced down all three paths in *an irregular order* [italics added] by putting blocks near entrances of *any two of the three paths* [italics added] at such points as x [see Figure 1b], y and z and they soon learned, as the result of this preliminary training, first to try path 1 and then, if this was blocked at x, to try path 2 and only then, if this also was blocked at y, to try path 3. (Tolman, 1933, reprint in Tolman, 1966, pp. 74-75).

Verification shows, without a doubt, that the forced runs "distributed equally . . . into the three paths" (Tolman & Honzik, 1930, p. 218) were indeed planned by TH, but only for Experiment I and to a lesser degree for Experiment II.

The numerical data noted in the account of Experiment III require commentary. They are paradoxical: Each rat did not have the same number of forced runs over Path 3 and the remainder from the division of 171 by 15 bears this out. They differ from one page to the next: It is surprising, for instance, to read that: "there was a total in all 13 days of training of 1357 runs with block A in place. . . . [and that] of the 1357 runs 1229 (90.57 per cent) were by way of Path 2, 128 runs (9.43 per cent) by way of Path 3" (p. 225) when in the Table on the following page, "the number of times each rat took path[s] 2 . . . when the block was at A" (p. 226) was down to 1214, though the number of Path 3 runs remained at a steady 128. Finally the presentation of these numerical data could result in their being underestimated: The number of runs on Path 3 was not 128, as might appear from the summary Table published by TH, but 128 (spontaneous) + 150 (10 special * 15)—an estimate based on TH's presentation of the 12 special runs (see *supra* the quotation from Tolman & Honzik, 1930, pp. 224-225)—+ 171 (forced) = 449. This is certainly a far cry from 1229 (or 1214 ?) Path 2 runs but, it is important to remember, these four hundred or so runs all ended with the rat reaching the reinforcing agent, unhindered.

On the 14th day, the day of the final test, 14 of the 15 rats which entered Path 1 managed to avoid Path 2 when retracing from the block at B on the section common to Paths 1 and 2. Yet this was, indeed, the first time the animals encountered this obstacle by way of Path 1. However, before TH could conclude, they had to “check the possibility that the rats might have become conditioned to the nature of the blocks, the glass block being a sign for Path 2, the wire block for Path 3” (p. 228). To do this, they planned an experiment, the relevance of which is difficult to assess. For, two irreconcilable versions of it were described. The first version can be summed up thus: Each rat had to make 11 successive runs which were given as follows “one training run with block at A, the next an “insight” run with block at B, the third a training with block at A, and so on” (p. 228). The second version is contained in the following lines:

In these alternated runs both the glass and the wire-netting blocks were used, and their positions were alternated between points A and B. For one run the glass block was at B, the wire block at A, and for the succeeding run the glass block was put at A, the wire block at B. (p. 228)

How can we see clearly amid such confusion?

But what do we know about this Group B, which Maier and Schneirla did not distinguish from Group A and to which only Dove and Thompson (1943) referred? It was formed by TH explicitly:

To ascertain the possible effect of the twelve special runs per rat which were introduced during Days 9-13 with Group A, viz the runs with blocks at E and B which might perhaps have been direct training for the ‘insight’ trials. . . . [thus] 10 male rats . . . [were] given training for 14 days but without these blocks-at-E-and-B runs. *Otherwise the general conditions were the same as for Group A* [italics added]. (p. 228)

With no other information on the experiment, are we to understand that on the second day of training, the rats in Group B were stopped by a wire-netting block at A, that they then (though when?) had to run along Path 1 because Paths 2 and 3 were blocked, that they made (about!) 11 “forced” runs over Path 3 and finally, that the wire-netting block was assigned to B although the glass indicated A? In any case, 7 out of 10 rats (compared to 14 out of 15 in Group A) took Path 3 during their first insight run, on 14th day of the experiment.

Having summed up the findings of Experiments I, II, and III, Tolman and Honzik (1930), Honzik, without more ado, concluded:

‘Insight’ in the sense in which we have used the term here, seems to be *definitely proved for Maze III with both Group A and Group B* [italics added]. That is, under the conditions of this

elevated maze and of the kinds and amounts of preliminary training given, the rats of both groups, upon *first* finding a block in the final common path, as a result of taking one 'entering' path (Path 1) *immediately* (i.e., without any trial and error learning) also avoided the taking of the other 'entering' path (Path 2). (p. 230)

Under "Discussion" which followed that pronouncement, TH did attribute the positive results obtained only in Experiment III to the maze not having "side walls . . . and hence the rats were able to 'see' the situation as a whole" (pp. 230-231). However, and as if to reintroduce "Insight" which they had chosen as their title, they added:

Or, even if the rats in Maze III were not able to 'see' all the paths at any one moment, they might still have been better able to grasp the connections between the paths, owing perhaps to the open space on all sides of the runways, which may have served to accentuate the relations between the paths. (p. 231)

Nevertheless, looking at a scale drawing of the maze constructed for Experiment III, it is very difficult to lend support to any assertion but Munn's: "The rat's behavior could be interpreted as responding in terms of stimuli, all of which were present at the time of response" (Munn, 1950, p. 272).

"Insight' in Rats," A Fable? No, A Commonplace

One can easily imagine Tolman and Honzik finding it convenient to return, in 1930, to the concept of insight Hsiao (1929, cited by Tolman & Honzik, 1930) had used the previous year. Likewise, one can understand Tolman replacing it two years later with inferential expectation or inventive ideation, which seemed more adequate to one for whom "behavior as behavior, that is, as molar, *is* purposive and *is* cognitive" (Tolman, 1932, p. 12). Be that as it may, one final question still remains: why the account of Experiment III, of the kind to bewilder any experimentalist still believing that "if the facts used as a basis for reasoning are ill-established or erroneous, everything will crumble or be falsified" (Claude Bernard, 1957, p. 13), did not in any way put the future of "Insight' in Rats" in jeopardy? For, in fact, nothing has crumbled; the TH experiment came to the aid of reasoning in the rat in 1964, served to illustrate place learning in 1975, and similarly, confirmed the concept of cognitive map. Everything is true, because even if Vauclair concluded with "the dependency of the hamster's spatial behavior on propiomotricity [my translation]," he chose in 1980 to

Re-examine the problem of insight and Tolman and Honzik's famous device because this behavior (*defined as an internal process of restructuring previous experience, without relearning* [italics added]) could be used as a prototype for discussing the

Tolmanian conception of the 'mental map' [my translation].
(Vauclair, 1980, p. 332).

In short, everything still stands and nothing is falsified even if Munn (1950) remained cautious and Gréco (1969) noted that "this experiment, which seemed to demonstrate so much is fragile, in reality [my translation]" (p. 176) and added, backing this up with references: "Tolman and Honzik's results were far less consistent and general than one might think [my translation]" (p. 177).

Why? We are sometimes tempted to think that the writers we examined, except Tolman, had not actually read TH's work or had, at best, merely skimmed through it. Yet, we prefer an equally simple answer, of hypothetical value only, of course. The researchers and theorists whose writings we consulted, disregarded the "details of experimental investigation" (Claude Bernard, 1957, p. 15); this enabled them, like "generalizers" (Claude Bernard, 1957, p. 15) to load the experiment with various concepts for which it was obviously an unsuitable base. However, the fame of an experiment generating a plethora of concepts owes more to literary success than to scientific consensus. From that point of view, Claude Bernard is still right. Everything has indeed crumbled unless we consider that the relationship between facts and reasoning is not the same at the end of this century as it was at the close of the last one.

One Last Word. Tolman invented the cognitive map in 1948. In this famous paper, he entered under five headings including "latent learning" (Tolman, 1948, p. 194), "searching for the stimulus" (Tolman, 1948, p. 200) or again, "spatial orientation" (Tolman, 1948, p. 203), the experiments which, to him, "seem specially important in reinforcing his theoretical position" (Tolman, 1948, p. 193). The third experiment of TH is not under any of these headings. Maybe he simply forgot research dating back 18 years? This is doubtful because Tolman and Honzik's writings on latent learning, published the same year as "'Insight' in Rats" are among those listed "to lend further support to the doctrine of building up of maps" (Tolman, 1948, p. 200). In fact, we believe that the empirical content of Experiment III which was already troubling him in 1930, in spite of his efforts to appear satisfied with it, did finally make him see reason. Not so his followers, however. On the contrary, as pupils so often do, they outstripped the master. Fitting out the ever-adjusted facts with his most famous concept, they completed the transformation of "'Insight' in Rats." The fable has become a commonplace.

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