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The Time, the Path, its Length and Strenuousness in Maze Learning*

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Previous findings show that rats in a maze tend to choose the shortest path to reach food. But it is not clear whether this choice is based on path length solely, or some other factors. The aim of this experiment was to investigate which factor dominates the behavior in a maze: path (longer and shorter), time (longer and shorter), or effort (more or less strenuous). The experiment involved 40 mice (4 groups), learning a maze with two paths. Each group went through only one of the situations within which we kept one factor constant on two paths while the remaining two factors were varied. Only in the fourth situation all factors were equalized. The results show that there is a statistically significant difference in the maze path preference between four situations. Preference between the paths is such that mice always choose paths requiring less effort.

Keywords: maze learning, cognitive maps, maze path length, time needed to exit the maze, effort required to exit the maze

Highlights:

- Effects of time taken to reach the goal were separated from path length during maze learning in mice.
- Effort required from a mouse to reach the goal was added as another factor for path choice in maze learning, which might be confounded in previous studies with path length.
- Dimensions of the path length, time and effort required to reach the goal in the maze were systematically varied.

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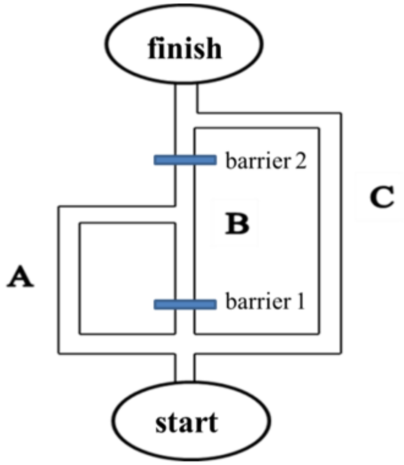
- Results clearly indicate that effort required to reach the goal is more important than time or path length for route choice in maze learning.
- Mice do not choose shortest or fastest route; they clearly choose least effortful route in order to reach the goal in maze learning.

Maze learning is a type of learning where the solution is found by trial and error, whereby the task of the respondent is to learn the correct route on every point of choice, and after that to learn successive trail of correct choices (Radonjić, 1992).

Among the first theories aimed for interpreting the behavior of rats during maze learning, S-R and Cognitive theory appeared (Radonjić, 1992). S-R theory emphasizes that a rat learns a set of movements in a maze; maze learning is based on blind trials and errors, which is confirmed by the fact that it leads to the successful elimination of blind paths and successful learning of the correct way for reaching the goal. The cognitive theory of maze learning considers that the maze is the place where learning occurs, that is, a rat remembers the position of the goal. Possibility of understanding spatial relations (the path layout in the maze, goal position, etc.), points to the existence of "cognitive maps" in rats (Spence & Lippitt, 1946; Tolman et al., 1946; Tolman, 1948). In one of their experiments, showing the existence of cognitive maps, Tolman and Honzik (1930) constructed a maze with three paths of different lengths, some of which were blocked by barriers (Figure 1). Results clearly showed that rats always tend to choose the shortest available path to reach the goal. If the shortest path is blocked by a barrier, then a rat would choose a shorter of the remaining two. Choice of the shortest possible route in order to reach the goal, indicated that rats do develop spatial maps, which is in line with cognitive theories. Recently, Wang and Hayden (2021), attributed cognitive maps formation to curiosity, which they described as: 1. willingness to sacrifice primary reward in order to obtain information; 2. the amount of reward a subject is willing to pay is related to the amount of available additional information; 3. that information provides no instrumental or strategic benefit.

Figure 1
Maze from the experiment by Tolman and Honzik



Although it is clear that rats can develop cognitive spatial maps, it is not clear based on which characteristic do rats actually choose the route. Rats' ability to learn the goal location is explained by findings that animals, in a totally unfamiliar environment, search for something familiar, which is then used as a landmark for further examining of the environment (Nemati & Whishaw, 2007). Rats are also able to successfully reach the goal by using certain visual simulations from the surroundings as keys for discriminating the paths (Schenk et al., 1997). Findings also point that rats are not only able to remember spatial maps, but also that neurons in the hippocampus play a crucial role in this process, and therefore younger animals, having more neurons, show better memorizing of spatial maps (Drapeau et al., 2003; Yousef et al., 2019). They can even transfer cognitive maps to mazes which are similar to the ones in which they had been trained (Nakagawa, 2003). Other researches show rats' ability to learn spatial maps in three-dimensional tasks (Grobéty & Schenk, 1992; Flores-Abreu et al., 2014) and to store sensory information in their working memory (Fassihi et al., 2014).

Besides S-R and Cognitive theory, behavior of animals in maze learning can be interpreted on the basis of biological theories, such as the Optimal foraging theory (Stephens & Krebs, 1986). According to this theory, animals strive to make the greatest energy gain per time unit; the decision on whether to attack a prey and thus provide itself with food depends on the relationship between costs and benefits. Similarly, according to the limit value theorem (Charnov, 1976), animals strive to satisfy their need for food by spending as little time and energy as possible. These theories indicate the importance of time and effort during the learning process. Some results show that rats will rather consume smaller amount of food found on the way (short-term reward) instead of investing more time to find a larger amount of food and risk losing previously found smaller reward (Kane et al., 2019); as opportunity costs increased, rats became increasingly reluctant to abandon potential food products (Wikenheiser et al., 2013). In a situation when the animals are not very hungry, the decision to eat is more determined by safety needs (Arcis & Desor, 2003). Also, a tendency of rats for shorter trips toward the food and a tendency to move in horizontal paths were shown (Davis et al., 2018; Grieves et al., 2020; Jedidi-Aioub et al., 2020). Jedidi-Aioub et al. (2020) point out that rats tend to choose vertical paths only if they are less strenuous than horizontal ones when reaching for food.

Once again, it is shown that rats tend to choose shorter paths in order to reach the goal in a maze, but it is not clear which characteristic do they rely on, since shorter paths lead to shorter time. If we carefully look at earlier research designs (Spence & Lippitt, 1946; Tolman et al., 1946; Tolman, 1948; Tolman & Honzik, 1930), two physically different values, the distance traveled and the time needed to reach the goal, are usually confounded. Also, according to the foraging theory, a similar equalization is observed, the animals make the decision to spend as little time and energy as possible (investing as little effort as possible) during feeding (Stephens & Krebs, 1986). In one experiment authors tried to separate the effects of path length and time taken to reach the goal on route choice in maze learning (Kostić, 2014). This was achieved by slowing down the animal's movement on a longer path by covering it with mud. Results did not show any significant difference in route preference (the shorter or the longer one), nor in time necessary to reach the goal on different paths. We might ask, why was the tendency to choose a shortest and fastest path toward the goal, which was confirmed by a number of earlier experiments (Tolman et al., 1946, Tolman, 1948), not found in the above-described experiment (Tošković, 2014)? If two paths differed in length and time needed to reach the goal, they also must require a different amount of effort to reach the goal, since one of the paths was covered with mud. It is previously reported that effort has an effect on animals' behavior (Salamone, 2009), and that rats tend to choose a smaller prize if it goes with less effort (Zhang et al., 2018). Also, in human subjects, it is reported that the effort needed to perform an action, can have a significant impact on perceived distance (Tošković, 2009, 2011, 2012). On that line, there is a possibility that walking on the mud required much more effort from the rats than walking on the wooden lining. This leads us to ask whether the effort required to reach the maze goal might be a decisive characteristic for the route choice.

The main aim of this study will be to differentiate between characteristics that could influence the mice route preference during maze learning and which were discussed in previously mentioned studies and theories. Although mice and rats are different species of rodents, the results of previous research (Ingram, 1988; Young, 2007) do not indicate the existence of differences in results obtained with rats or mice as experimental animals. Some results obtained in water maze, indicate that rats do show better spatial abilities than mice (Whishaw & Tomie, 1997; Frick, 2000), but in dry-land spatial tasks, no differences between these species were found in terms of their spatial abilities (Whishaw & Tomie, 1997). As we mentioned, the authors of previous studies did not separate the distance traveled (path length) from the time necessary to reach the goal or the effort required to reach the goal. Since the findings show that animals tend to choose the shortest path in the maze, we cannot tell whether it is because of the path length itself, or due to less time or less effort required to reach the goal on that path. Therefore, the aim of this study was to examine which of the following three factors, shown as important in animal learning but not differentiated in previous studies, is the most important for the route preference during maze learning: 1) The length of the path passed; 2) The time needed in order to reach the goal, or 3) Amount of effort required to reach the goal.

According to S-R and cognitive theories of learning it is not possible to make clear predictions whether path length, time or effort will have the highest effect on path choice, since these two groups of theories only distinguish whether there will be a path preference or not. But, having in mind more recent findings and theories which stress out the importance of effort for animals' behavior (Stephens & Krebs, 1986; Salamone, 2009; Zhang et al., 2018), or human perception (Tošković, 2009, 2011, 2012), we might assume that the amount of effort required to reach the goal will be more important for route choice then path length or time.

Method

Pilot Phase

Our aims demand a specific maze design, which will allow us to draw precise conclusions and answer research questions. Therefore, we performed a pilot experiment in order to carefully design such a maze and experimental situations for the main study.

Sample

Six mice in total (3 female) participated in this phase, species mus musculus (NMRI Hann– white mice; 6 weeks old). Mice were reared in a laboratory in the Clinical Center of Serbia (Belgrade), in typical mice vivarium conditions. These animals participated only in the pilot phase of the experiment. In the pilot phase we had three situations and in each of them two mice participated.

Procedure

Difference in path length. In order to be sure whether an adequate maze will be made for a main study, first of all, we had to determine the lengths of the two paths which would create preferences in path choice. The difference in two path lengths should be such that mice would really perceive them as different in length.

Difference in effort. After determining the difference in path lengths that mice perceived as different, the time needed to go through the shorter path should have been shorter, as well. According to that, it was necessary to determine how to increase the effort of moving along the shorter path through the maze in such a way that the time necessary to reach the goal on that path would be equal to the time needed to reach the goal on the longer, but easier path.

Difference in time. The last 2 mice were used in the situation where we checked whether the time needed to reach the goal is different on more and less difficult paths although both paths are the same in length.

Results

Due to a small sample size, including only two animals in each situation, we did not perform any significance testing on data gained from the pilot phase. This phase was used only to get a rough estimate for creating a maze for the main study. At the end, according to data gained in the main study, on appropriate sample size, these effects were statistically tested and verified.

According to descriptive statistics gained on two mice, results showed that preference for the shorter path clearly appears when path dimensions are 40cm and 60 cm. Further on, by placing two 8 cm height barriers, which another two mice had to cross over, we equalized the time necessary to reach the goal on that path with the time on the longer path without barriers. And lastly, if both paths were equal in length, the last two mice did need less time to reach the goal on a path without barriers (requiring less effort to reach the goal). According to these results we constructed the final version of a maze and planned further procedures in the main experiment (Figure 2).

Main study

Sample

In this study 40 experimental mice (20 females) participated, mus musculus species (NMRI Hann– white mice), two months old, participated in this study. Mice were bred in a laboratory at the Clinical Center of Serbia (Belgrade), in typical conditions of a vivarium. The animals were divided into four groups of 10 mice and participated only in the main study. Since mice were randomly assigned to groups and sex distribution was the same in all groups, we believe that additional factors effects, such as estrus cycle in female animals, were controlled. We kept mice in cages where they usually live. Half of the day they were exposed to the light, and the second half they spent in the dark. Each group was tested in only one of the four experimental situations that will be described in the procedure.

Stimuli and Instruments

For this experiment, two mazes were constructed, and they consisted of two paths, both leading to the goal. In one maze, both paths were equally long (60 cm), while in the other maze the shorter path (40cm) was on the left side, and the longer one (60cm) was on the right side.

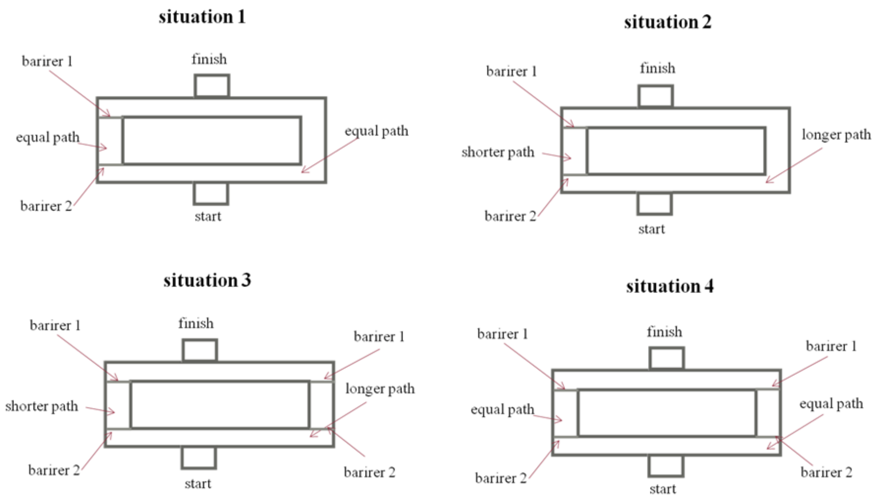
Procedure

With all previously determined characteristics in the pilot phase, four experimental situations for the main phase were constructed, as follows (Figure 2):

Situation 1. in this situation lengths of both paths (s_1 and s_2) by which one reaches the goal were equalized (60cm), while the amount of effort necessary for reaching the goal (e_1 and e_2) and time necessary in order to reach the goal (t_1 and t_2) were varied. The effort is varied by placing two barriers of 8 cm of height on one path (s_1), and accordingly, more time was needed to pass that path in order to reach the goal.

Situation 2. in this situation time needed (t_1 and t_2) to reach the goal was equalized, while the paths lengths (s_1 and s_2) and amount of effort (e_1 and e_2) required reaching the goal were varied. On the shorter path (40cm) there were two 8 cm height barriers, while on the longer path (60 cm) there were no barriers.

Figure 2
Scheme of experimental situations



Situation 3. in this situation the amount of effort necessary for reaching the goal (e_1 and e_2) was equalized (both paths had barriers), while path lengths (s_1 and s_2) and time necessary to reach the goal were varied (t_1 and t_2).

Situation 4. in this situation, paths lengths (s_1 and s_2) which led to the goal, the amount of effort (e_1 and e_2) and time required to reach the goal (t_1 and t_2) were equal. Both paths were 60cm long, and both of them contained two barriers of 8 cm in height.

In the first part of the experiment, mice were let into the maze, 5 days in a row, five minutes per each one, in order to develop a spatial map of the maze. In that situation, they were always released into the maze in the same places (start) and were able to find food on the board that represented the target in the maze (goal). It is important to note that in this phase mice did not just wander around the maze; they were rather directed toward the goal by the food (0.5 g of seeds and cereals). During the training period, experimental animals had sufficient quantities of food and water and in that period, they got used to the maze. After five days a period of 3 days of starvation followed, during which they were provided only with water and without any food.

In the second phase of the experiment, each mouse was let 10 times into the maze. At the end of the maze, there was food, the same as mice consumed in cages during the training period, exactly 0.5 gram of seeds and cereals. In each attempt, it was noted which route the mouse had chosen in order to reach the food and time it needed to reach the goal on that route. Finally, we calculated the proportion of choices for each route (s_1 or s_2), as well as the average time necessary to reach the goal, for each mouse, on each path, in all four situations. A number of choices for each route was divided by a total number of trials, providing a proportion of choices for each route, which ranged from 0 (the path was never chosen) to 1 (the path was always chosen). Since the proportions of two route choices are complementary and add up to one, for further analysis we decided to use the proportion of choosing a path on the right.

This research was approved by an ethics committee from the Department of Psychology, Faculty of Philosophy, University of Belgrade, Serbia, under protocol number 2019–045.

Results

In order to check which factor was the dominant one for the route choice during the maze learning, via the four examined situations, we separately analyzed route preferences and the time needed on a chosen path in order to reach the goal.

Route Preference

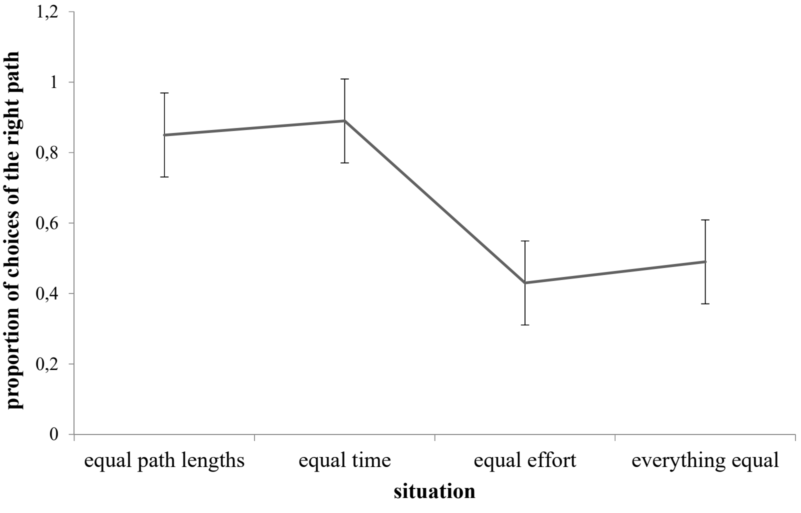
In order to test differences between four experimental situations in route preference we applied one-way analysis of variance. Results show that there is a significant difference between four examined situations in the route preference ($F(3, 36) = 20.01$, $p < .001$). Sidak post-hoc test showed that in situations in which the effort was equalized and when all three parameters were equalized (effort, time and path length), mice equally chose the path on the left (s_1) and on the right side (s_2). In situations in which path lengths or time required to reach the goal were equalized, mice more frequently chose the path without barriers (s_2) regardless of the fact whether such path was longer or not (Table 1, Figure 3). These results suggest that only in situations in which effort differed on two paths, there was a preference for one of the paths.

Table 1
Post-hoc Sidak test for differences in route s_2 preference between 4 situations

Situation (A)	Situation (B)	**Mean difference (A-B)**	***SE***	***p***
Equal path length	Equal effort	.42	.75	.00
	Equal time	-.04	.75	.99
	All equal	.36	.75	.00
Equal time	Equal effort	.46	.75	.00
	All equal	.40	.75	.00
Equal effort	All equal	-.06	.75	.97

Figure 3

Proportion of choices of the path on the right (s_2), in four experimental situations



In order to test whether path preference exists in all or just in some situations, we performed two-way ANOVA, with the situation as a between-subject factor, and path (left or right) as a within-subject (repeated) factor. Analysis revealed significant interaction of the two factors ($F(3, 36) = 19.02$, $p < .001$), meaning that path preference does not appear in all situations. Sidak post-hoc test showed that path preference appears only in situations in which path length and time to reach the goal were equal. In situations in which the effort was equalized and when all three parameters were equalized (effort, time, and path length) there was no path preference, and both paths were chosen with equal probability (Table 2).

Table 2

Post-hoc Sidak test for differences between two routes preference in 4 situations

(s_1 path choice – s_2 path choice)	**Mean difference**	***SE***	***p***
Equal path length	-.70	.105	.00
Equal effort	.14	.105	.19
Equal time	-.78	.105	.00
All equal	-.06	.105	.57

Another way to examine our hypothesis was to test the effects of all three characteristics on path choice in regression analysis, by predicting the relative frequency of choosing a path on the right based on three situations represented as binary variables, equalized path, equalized time and equalized effort. Results showed a significant prediction ($F(3, 36) = 19.95$, $p < .01$, $r^2 = .62$), but only the equalized effort situation turned out insignificant ($\beta = .03$, $p > .05$). This result additionally shows that the only characteristic which affects path choice is an effort because only in situations in which effort varies, equal path lengths (β = .68, $p < .01$) and equal time (β = .73, $p < .01$), there is a path preference.

The Time Needed to Reach the Goal

We also tested whether times on the two paths differ depending on the situation. Two-way analysis of variance was applied, with the experimental situation as a between subject factor and path (left or right) as a within subject (repeated) factor. Analysis showed significant interaction of situation and path ($F(3, 27) = 14.67$, $p < .001$), indicating that time taken on two paths probably differed in some but not in all situations, as we expected according to experimental design. Sidak post-hoc tests show that only in the situation in which both paths were equal in length but differed in the amount of required effort, there is a significant difference in the quantity of time spent during reaching the goal between the two paths (Table 3). Mice on average needed more time to reach the goal on the path $s_{1,}$ which, in this case, contained barriers and required more effort to reach the goal. In all other situations, in which we equalized time, effort, or all three factors, the results show that there was no difference in the quantity of time spent for reaching the goal on two paths (Table 3).

Table 3
Post-hoc Sidak test for differences between time taken to reach the goal on two paths in 4 situations

Situation	**Mean difference in path time**	***SE***	***p***
Equal path length	-4.49	0.63	.00
Equal time	-1.04	0.69	.14
Equal effort	0.83	0.49	.10
All equal	0.23	0.49	.64

In order to check the importance of time for the choice of path, we correlated differences in time needed to reach the goal on two different paths with the preference of the path on the right, in all four experimental situations. Pearson correlation coefficient did turn out statistically significant and negative, but the effect size was moderate to high ($r = -.57$; $p < .01$). This means that the slower the path on the right side is (time difference is larger), mice tend to choose it less frequently, which indicates the importance of time for a path choice.

Discussion

The main aim of our study was to determine which of the three factors (path length, time travelled or effort) is the most crucial one in choosing a path in a maze. This is important, since from previous findings showing that rats tend to choose the shortest path, it is not clear whether they do it because of its length, time taken to traverse it, or effort required to pass it. We created an experiment in which those factors were varied in four experimental situations. Results showed that there are differences among situations in terms of preference of maze paths, and now we will describe them in more detail, trying to conclude which of the factors is the most important one for the path choice.

Situation 1 (equalized path lengths)

In this situation, both paths are equally long, but path s_1 contains barriers and therefore requires more effort and time to reach the goal, while path s_2 is without barriers. Results show that mice more frequently choose path s_2, on which they need less effort and less time to reach the goal. On the basis of these results, we may come to the conclusion that the amount of required effort and/or time necessary to reach the goal is crucial for path preference in the maze.

Situation 2 (equalized time)

In this situation, the path s_1 is shorter and it has barriers (requires more effort) while the path s_2 is longer but it has no barriers. Accordingly, both paths require the same time to reach the goal, which is confirmed in the results (Table 3). In this situation, the mice chose path s_2 more often, which guides us to the conclusion that the amount of required effort for reaching the goal is a significant factor for path choice in maze learning. Now we can exclude time as a significant characteristic since there was a route preference although the time of reaching the goal was equalized. But also, we can exclude path length as an important factor for path choice, based on two arguments: (1) in the previous situation, there was a path preference although path lengths were equal; (2) in this situation, path s_2 was preferred although it was the longer path. Summing up results from the first two situations, we can see that the required effort remains the only important factor for path preference. Therefore, we would expect no path preference if the amount of effort would be equal on two paths.

Situation 3 (equalized effort)

In this situation both paths have barriers, but the route s_1 is shorter, while route s_2 is longer. In this situation, both paths require the same amount of effort, while route s_2 is longer. Results show that the mice equally frequently choose both paths s_1 and s_2. On the basis of these results, we can conclude that the required effort is crucial for the choice of path in the maze since if the two paths require the same amount of effort, mice choose paths equally. These results also show that the other two factors are not crucial, since, although the path s_1 was shorter, and at the same time, equally difficult as the path s_2, the mice do not prefer it. This finding is in accordance with optimal foraging theory (Stephens & Krebs, 1986) and some research showing that the choice of trajectory in the maze is partly determined by the amount of effort required (Jedidi-Aioub et al., 2020). Besides that, it might be interesting to relate the importance of effort in maze learning with effort effects on distance perception shown in humans (Witt & Proffitt, 2008). According to these findings, one's ability to perform the action influences perceived distance. Similarly, our results indicate that the animal's choice of shortest path in previous findings is probably due to less effort required on that path in order to reach the goal.

Situation 4 (all factors equalized)

In this situation, both paths are equal in length and on both of them two barriers are placed, meaning that both paths require the same effort and time to reach the goal. Results show that the mice in this situation equally choose both routes.

Summing up all the above-described results we can see that in situations in which both paths required the same time and both paths had equal lengths, mice preferred path s_2, which required less effort (without barriers). On the other hand, in situations in which both paths required the same amount of effort and or in which all three factors were equalized (the path length, time and effort), mice equally choose both paths in the maze. These interpretations are in line with other findings of effort effect on animals' behavior (Salamone, 2009; Zhang et al., 2018). But we might ask, are there other possible interpretations of these findings?

First of all, were all situations well designed? As for time variations, in all situations in which paths were designed to require equal time to reach the goal, results showed no differences in goal reaching time. Also, in all situations in which paths were designed to require different time to reach the goal, results showed significant differences in goal reaching time. These results uniquely show that all four situations were well-set regarding time.

In situations with equalized time, mice did not show path preference, indicating that time was not an important factor in path choice during maze learning. On the other hand, we obtained a negative correlation of path preference with time needed to reach the goal (slower the path is, mice tend to choose it less frequently), which indicates the importance of time for a path choice. But effect size shows that only 35.4% of path choice variance can be explained based on time while the remaining 64.6% can be attributed to other factors. Having in mind that throughout various experimental situations time is correlated with path length and effort, even those 35.4% cannot be attributed to time solely. Also, in regression analysis we showed that 62.4% of the variance in path preference can be attributed to differences in effort solely. Taking these findings together, we can conclude that effort is a far more important factor for path choice in maze learning than time taken to reach the goal.

Path lengths were easily set according to design requirements, and both paths were 60cm long when they were supposed to be equal, or one of them was 40cm and the other 60cm long when they were supposed to be different. Also, in the pilot phase, we confirmed that this difference in length was sufficient since there was a preference for a shorter path. But one might ask, are path length and effort confounded, since longer paths require more effort. This might be true in some sense, but in that case, we would expect to find a difference in path preference in situation 3, in which both paths required the same amount of effort, while route s_2 was longer. Nevertheless, our results showed that no path preference occurred in this case. Also, if it is true that effort and path length are confounded, it would be hard to explain the preference for longer and less effortful path in situation 2 (equalized time), in which the path s_1 was shorter with barriers (required more effort) while the path s_2 was longer and without barriers. Comparing results from these two situations, which show lack of path preference when they differ only in length or even a preference for a longer path when the shorter one contains barriers, we can conclude that effects of path length and effort are separated in our research design and that they do not confound each other.

The effort was varied by adding or removing two 8cm high barriers on the paths, and therefore we might doubt that those barriers extend the path length up to 32cm. According to that, the shorter path with barriers would be 72cm long, instead of 40cm, which would make it longer than the other path, which was 60cm long. If this would be true, we might conclude that path preferences in situations 1 and 2 are not due to the effort, but due to the fact that path on the right was shorter (60cm): path on the left would be 92cm long in the first (60cm + 32cm), or 72cm (40cm + 32cm), in the second situation. First of all, we might doubt that large variations in path length differences, 32cm in situation 1 (92cm – 60cm) and 12cm in situation 2 (72cm – 60cm) can produce the same preference effects, 85% to 89% for the path on the right. Besides that, if path length would be the most important factor, then we would expect to find a difference in path preference in situation 3, in which both paths contained barriers, while route s_2 was longer and required more time to reach the goal. Our results clearly showed that no path preference occurred in this case, and therefore we can conclude that path length is not the important factor for path choice in maze learning. Based on this, we can conclude that even if barriers increased path length, effects in path preference were not due to the path length, but clearly due to the required effort on a certain path. As mentioned before, effects of effort shown in this study can be related to other findings which indicate, for example, importance of effort for perceived distance in humans (Tošković, 2009, 2011, 2012; Paterson et al., 2019; Witt & Proffitt, 2008). It seems like effort required to perform certain actions can be linked to perception of certain characteristics, such as distance. This kind of linkage might further affect other actions, such as path choice in maze learning. Therefore, it might be important to cross-examine the effects of effort gained on human and animal participants, and also to link basic principles of learning with processes such as perception.

Conclusion

We can see that all results point out a strong preference of paths without barriers during maze learning. First of all, mice show a clear tendency for choosing paths requiring less effort (without barriers) in situations in which paths differ in the amount of effort. Also, in situations in which two paths require an equal amount of effort (both have barriers), mice do not show any route preference, regardless of the fact whether some of the paths required less time to reach the goal or whether some paths were longer or shorter. Comparing results from all four situations, it is relatively clear that when the effort is varied, mice tend to choose a path requiring less effort, while when the effort is not varied, there is no route preference in the maze. Based on previously discussed arguments, we can rule out path length and time required to reach the goal as important factors for path choice. Accordingly, we believe that our results point out the crucial role of the amount of required effort to reach the goal in path choice during maze learning.

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Vreme, put, dužina i težina puta u učenju lavirinta

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Prethodni nalazi pokazuju da pacovi u lavirintu imaju tendenciju da biraju najkraći put do hrane. Međutim, nije jasno da li je ovaj izbor zasnovan samo na dužini staze ili i na nekim drugim faktorima. Cilj ovog eksperimenta je bio da se ispita koji faktori su glavni za ponašanje (miševa, prim. prev.) u lavirintu: dužina puta (duža ili kraća), vreme potrebno da se put pređe (duže ili sporije) ili napor potreban da se savlada put (manje ili više zahtevno). U eksperimentu je učestvovalo 40 miševa (u četiri grupe) koji su učili lavirint sa dve staze. Svaka grupa je bila samo u jednoj situaciji, a unutar svake situacije (svakog lavirinta, prim. prev.) smo držali jedan faktor konstantnim u obe raspoložive staze, dok su ostala dva faktora varirana. Jedino su u četvrtoj situaciji svi faktori bili jednaki. Rezultati pokaziju da postoji statistički značajna razlika u preferenciji putanje u lavirintu između četiri ispitivane situacije. Preferencije su bile takve da su miševi uvek birali putanju koja zahteva manje napora (koju je lakše preći, prim. prev.).

Ključne reči: učenje lavirinta, kognitivne mape, dužina putanje u lavirintu, vreme izlaska iz lavirinta, napor potreban da se izađe iz lavirinta

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