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Geometrical and Spatial Cues

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Two guinea pigs (cavia porcellus) used as subjects were tested based on choice of geometrical (intra-maze) cues or spatial (extra-maze) cues when searching for food. They were trained in a rectangular box over 13 trials to learn where a treat was placed and then they were tested in a triangular box with 3 rotations to test whether they choose to rely on geometrical cues or spatial cues. Results were not significant and showed no preference for choice of cues. One guinea pig 2/3 of rotation preferred to rely on geometrical cues and the other relied 2/3 times on spatial cues. This leads to 3/6 choices for geometry and 3/6 choices for spatial which amounts to 50% for each cue.

Various studies have been conducted regarding spatial and geometrical cues in rats. Some researchers have found support for geometrical (intra-maze) cues as being the favored choice when trying to find food and others have found evidence to support that rats use spatial (extra-maze) cues when attempting to find food. Spicer (2001), trained four rats in large rectangular enclosure devoid of any featural cues to locate a reinforcer buried in one target corner of the apparatus. During phase 1, half the rats were run with external cues and half were not. In phase 2, the groups were switched to the alternative condition. During testing, she added a partition making the rectangle smaller and changing the relation of the target corner to the geometry of the box. She found that when external cues were available, the rats dug significantly more often at the corner that was correct according to absolute geometry and when external cues were eliminated, the rats dug significantly more
often to the corner that was correct according to relative geometry; suggesting that rats have different mechanisms for different cues available.

Another study relating this issue regards Cheng’s (1986) study. He trained rats in a rectangular box with each corner having featural information panels. He trained the rats by putting a reinforcer in one of the corners with featural information. He found that when the geometric relations between the target and the shape of the environment changed such as rotating the box at a 180 degree angle, the rats showed a tendency to stick to the location that previously had correct geometric properties. He argues that rats base their retrieval on geometric properties of the location of the target and not on the featural information. He also adds that rats seem to rely on its geometric relations to the shape of the environment, plus features near the geometrically specified target place; the featural information is dependent upon some shape or geometric record of the environment.

Brown and Wintersteen (2004) trained rats with a checkerboard pattern box that involved 5 x 5 vertical poles that were baited using two different checkerboard patterns. They varied visual cues with no visual cues and found that rats used visual cues. The central question was whether control by the spatial pattern would be facilitated by these cues. They also hypothesized that if the same memory for pole locations was involved in the ability of rats to avoid revisits to poles and to remember the location of the pole already visited then the cues identifying those locations should facilitate these abilities. They found when visual cues were absent, the rats made more than twice as many mistakes as when visual cues were present. However, the rats’ performances in the presence of visual cues
were always below chance (50%) therefore concluding that there was no evidence that the distribution of move types (relating to the checkerboard) following choice of baited versus unbaited poles were modulated by the presence of the cues. This did not support their hypothesis and therefore suggests another process which may be involved in encoding information.

The present study is to determine whether guinea pigs use geometrical cues (intra-maze) cues or spatial cues (extra-maze) cues. Based on these studies, the hypothesis is that they will use geometrical cues when in an ambiguous situation relating to food search. They will choose the geometrically correct corner even though it is wrong spatially especially in situations were there is no possible spatial location to further the support the use of geometry in food search.

Method

Subjects

Two female guinea pigs (*cavia porcellus*) were used for the experiment and were originally from Super Pet, London. They were approximately 7 weeks old on arrival and did not weigh anymore than 400 g and were housed in a plastic cage bottom with wire side walls and top which has plastic openings to allow access to inside the cage where there was one food bowl containing Hagen’s Original Blend: Guinea Pig Pellets distributed by Rolf C. Hagen Inc located in Montreal, QC; and another bowl which contained Katee’s Natural Timothy Hay distributed by Katee Products, Inc. located in Chilton, WI. The bedding was made by Living World pine shavings distributed by Rolf C. Hagen Inc. located in Montreal, QC. There was also a little house to allow shelter from any unwanted visitors to avoid stress on the
animals. The guinea pigs were placed on ad lib water and were not placed on a food deprivation schedule since they are always willing to do something for treats. The treats for guinea pig 1 (GP1) were her preferred treat carrots, and guinea pig 2 (GP2) preferred apples. During the latter part of the experiment GP1 weighed 860 g and GP2 weighed 920 g compared to their weight 700 g and 680 g at the beginning of the experiment.

The cage was located in the living room of a fourth floor apartment where temperature was always approximately 72 degrees F. They were tested late at night at approximately 10 o’clock to avoid any unwanted noise that would otherwise be present during the day or evening. Prior to this experiment, the two guinea pigs had never been involved in any other experiment of any sort.

**Apparatus**

The guinea pigs were trained in a homemade rectangular box and tested in a homemade triangular box. Both boxes were made with 1.9 cm wide white oak wood walls and bottom lined with pine shaving bedding. The width of the rectangular box was 45 cm, the length 65 cm, and the height 15 cm. The triangular box was 65 cm in length, 45 cm in width at the right angled corner, and 2 acute 45 degree angled corners. The extra-maze cues available to the guinea pigs were: a chair placed 87 cm on the east side, a wall with a white base board at 35 cm south, a dresser and the experimenter 1.4 m west, and a white curtain 1 m north to block off the living room. The experimenter was always placed at the same location marked on the floor to ensure stability in extra-maze cues. It is important to note that the location of corners and extra-maze cues were marked to ensure that all corners were
placed back the exact locations after rotations were made and all extra-maze cues were always at exactly the same distance.

Procedure

The guinea pigs were placed the rectangular box one at a time. The treat was placed at the south-east (SE) corner for GP1 and at the south-west (SW) corner for GP2 (Appendix A). The training lasted 13 days with three trials per day per guinea pig. The first phase included the treats to be placed on top of the pine shavings until they got the correct location 3 out of 3 trials; the next phase included placing the treat half way in the shavings until they were able to get the treats at the correct corner 3 out of 3 trials; the third phase included completely hiding the treats under the shavings until they were able to dig it up correctly on 3 out of 3 trials. Once they were trained to do so, they were ready for the testing phase.

During the testing phase, the triangular shaped box had one right-angled corner and two acute 45° angle corners. There were three rotations for the triangular box for each guinea pig (Appendix B). During every rotation, a handful of food pellets were placed at every corner to control for smell. GP1 always had the treat placed at the spatially correct corner (the SE corner) and GP2 always had her treat placed at the spatially correct corner (the SW corner) seen in Appendix B. This was to test that although the food is in the spatially correct corner, the guinea pigs, if using geometry, would not go to that corner even though the food is still there to further support for geometry as a choice. A choice of corner involved a dig for the treat. It was measured whether the guinea pigs would chose to go to the spatially correct corner, or choose the geometrical intra-maze cue for treat recovery. The
third rotation has no spatially correct corner, it was meant to create a further ambiguous situation, and therefore was measuring whether the guinea pigs would go for the right-angled corner (geometrical) cue in this ambiguous situation.

Results

The results were not significant in any way. Guinea pig 1 chose two out of three rotations the geometrical corner, and one spatial location. Guinea pig 2 chose two out of three rotations the spatial corner, and one geometrical corner (the 3rd trial where there was no correct spatial corner). In other words, three out of six trials (50%) choices involved geometry and three out of six choices (50%) involved spatial cues.

Discussion

The results do not support the hypothesis that the guinea pigs would choose geometrical cues when in an ambiguous situation relating to food search even though it was spatially wrong. The second assumption that the guinea pigs would also choose the geometrical corner especially in situations were there is no possible spatial location was supported since GP1 went to the geometrical corner but especially because GP2 went to this corner and she had chosen spatial corners on the other two trials. The results do not support research of previous experiments done on rats by Cheng (1986), Brown and Wintersteen (2004), and Spicer (2001). One thing to note is Spicer’s (2001) results indicated that rats had different mechanisms for different situations when remembering where food had been acquired. This could explain why one guinea pig chose geometrical versus spatial and the other did the opposite. It is possible that there may be individual differences
in guinea pigs and one may be more likely to rely on spatial cues rather than geometrical cues and vice versa. Each guinea pig may have a mechanism more developed than the other to account for these individual differences.

There are numerous limitations of this study that need to be considered. The first concern the guinea pigs themselves. Age may have been a factor since they are not even a year old yet and therefore they do not have any prior experiences of this kind of manipulation; and, on top of both being young, GP2 is younger by a month than GP1. Perhaps maturity would have allowed certain mechanisms to develop to be more experienced and capable of doing these kinds of tasks, as well as the difference in age may have lead to individual differences. Another problem is the time of day, perhaps late at night is not the best time to test guinea pigs. It is possible their peak is earlier during the day and therefore could have hindered their performance. If their peak time is earlier during the day, doing a somewhat complex task that demands some memory and cognitive abilities may be difficult under these circumstances. On the same note, noises that are not familiar scared the guinea pigs which in turn made them freeze for a couple of minutes before they realized there was nothing wrong. This could have possibly affected their concentration and their processing of the information that was in front of them. When interrupted, they may not have remembered what they were doing and therefore the interruption hindered their learning experience in the training phase and performance in the testing phase.

A final factor involving the guinea pigs is their fear of the box and separation anxiety from each other. Since the box was a new environment with a new smell,
this made them weary of what was going on. They were placed together in the box for 20 minutes together everyday for 1 week to make sure they got used to the smell of the box and also allow their smell to stay in the box to make them aware they had been there before. Afterwards, when GP1 was placed alone in the box the following week, she would cry out for the other to make sure GP2 was still in the room and that she wasn’t alone which hindered learning of where the treats were placed. The same happened for GP2. In order to avoid this, the guinea pigs were placed one by one in the box for 1 minute the first night, 5 minutes the next night, 10 another night, and 15 minutes the last night. Although these issues were dealt with, one wonders if the fear of being in a new place alone was still an issue and had an effect on the differences in performance. Based on if they coped with this situation, they may have had differences in coping which lead to different learning patterns, which lead to differences in performance. Also, relating to age, it is possible coping and learning in different situations may come with age and therefore GP1 possibly had an advantage over GP2.

Other factors involve the design and the environment where the experiment took place. The design’s limitations involve the amount of testing trials and the amount of guinea pigs tested. Considering there were only 2 guinea pigs, more trials would have been beneficial to determine choices to criterion. Since, the treats were placed in the spatial corner during the testing trials; further testing of different rotations could have lead to practice effects since the guinea pigs were being reinforced by getting the treats in the spatial corner given if that was a choice they made. Considering both made at least one spatial choice, they were reinforced at least
once; and once a behaviour is reinforced, it is difficult to stop it. Probe trials may have been the proper choice in the testing phase to allow for more trials of the rotations and have choice to criterion data to determine a preference between cues.

Another factor may be the actual size of the box. If the boxes were larger, perhaps the results may have been different because the guinea pigs would have had to run around a little more leading to more information being processed. A larger box may have influenced the way they encoded the information and in turn may have made the results lean more towards one cue more than the other and not a total 50% split.

The last issue concerning the design involves the amount of guinea pigs used. Having a greater number of guinea pigs could have benefited the experiment because the results may have leaned more towards one of the cues rather than equal choices. Having a larger sample size would have probably produced significant results for one of the cues and also may have supported past research on these issues with rats.

Another limitation involved the environment. This experiment was conducted in an apartment building and therefore masking every type of noise and sounds was impossible, which as discussed earlier, was a problem for the guinea pigs. There was no way to control any of these noises. There was also an overwhelming amount of extra-maze stimuli that the guinea pigs could have used as cues and it is possible GP1 ignored these completely as a coping strategy because this much stimuli was too much to process and chose to rely on the intra-maze cues; hence, geometry.
Future studies concerning this experiment should address these issues. Firstly, having an older and larger sample of guinea pigs may have an effect on the outcome in the future since the guinea pigs would be more mature and possibly more attentive to the task as well as a larger sample which could avoid the complete 50% split between the two. Another suggestion for future studies is the environment and the time of day. If the study would have been conducted in a lab environment which would mask most of the noise during the time where the guinea pigs appear to be more active, the results may have been more consistent between the two; that choice of one cue may have prevailed over the other since learning would not be hindered. As for separation anxiety, this could also have been avoided in a lab setting because one guinea pig would be in the testing room, the other would stay either in the central room or in a cage room where the communication between the two would be impossible and therefore would not hinder on learning the task or performing the task since they would not be able to communicate.

Another issue was the amount of testing trials per rotation. There was only 1 trial per rotation which does not give a lot of data. Therefore, probe trials could have been used to test for example 3 trials per rotation to determine whether there was a preference in choice of cues or; would possibly demonstrate there is no difference in choice of cues. The size of the box could have had an effect as well since it was not overly big. Future studies could try different box size to see whether that issue matters or not.

Finally a suggestion for future studies is to try to eliminate all extra-maze cues to determine whether the guinea pigs rely on the intra-maze cues (geometry) since
that is the only cue given, and then add the extra-maze on other trials to see if they still rely on the geometry or if the switch over to using the spatial cues. If they do, then possibly, as Spicer (2001) argues, this could demonstrate the guinea pigs have different mechanisms for different cues available or support Cheng’s (1986) argument that they rely on spatial information dependent upon geometry.
Appendix A

Figure 1. The training box for guinea pig 1 including the area (south-east corner) where the treat was placed throughout the training denoted by “x”.

Figure 2. The training box for guinea pig 2 including the area (south-west corner) where the treat was placed throughout the training denoted by “x”.
Appendix B

Figure 2. Rotations for Guinea Pig 1 and where the treat was placed. In figure 2 (a) the guinea pig’s treat is placed at the south-east corner (denoted by ‘x’) as well as for figure 2 (b). In figure 2 (c) there is no south-east corner where the treat can be placed which forces the guinea pig to rely on geometrical cues (denoted by ‘y’).

Figure 3. Rotations for Guinea Pig 2 and where the treat was placed. In figure 3 (a) the guinea pig’s treat is placed at the south west corner (denoted by an ‘x’) as well as for figure 3 (b). In figure 3 (c) there is no south east corner where the treat can be placed which forces the guinea pig to rely on geometrical cues (denoted by ‘y’).
References

