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Abstract

Previous discrimination learning research showed that other animal test subjects have successfully learned the transposition concept. When new shades, shapes or sizes of stimuli were introduced to these animals, they successfully applied their transposition concept to the new stimuli and chose the appropriate stimuli. This study examined horse's ability to learn a relational concept, "pick the bigger" of two shapes, and then apply it to shapes and size relations it had never seen before. Four Equus Caballus were required to learn a relational concept of "pick the bigger" for either squares or circles and apply this concept during discrimination tasks based on relative size. It was found that the subjects did not learn the relational concept during training and the experiment was terminated. It was concluded that horses cannot transpose.

Keywords: Discrimination Learning, Horses, Transposition

Discrimination learning has been used to assess the cognitive abilities of many different animal species. This method can be used to test an animal's ability to predicate a response on the basis of relational rather than absolute concepts (Brezinsky & Pepperberg, 1991). Research has examined how animals respond to relationships amongst stimuli as opposed to responding to individual stimuli. Some researchers had also subdivided abilities with respect to relational concept into two levels. The simpler level involved understanding relative class concepts e.g darker than (Brezinsky et al., 1991). Responding to relationships and class concepts and not to individual stimuli is a much more complex task. The subject must understand the stimuli as a whole and acknowledge the class concept that is present amongst the stimuli. Instead of responding based on one specific stimuli, the subject must learn about the stimuli as a group and respond based on the relationship acting in that group. The current study tested horses relational concept abilities, specifically the simpler level which involved understanding relative class concepts which in the current experiments was ‘larger than’. The study aimed to determine if horses could understand the class concept in the stimulus pair and then respond based on the relationship between the stimuli. The most direct evidence for relative learning came from transposition experiments (Brezinsky et al., 1991). Transposition experiments have tested animal’s relative learning and relational learning and was used to test horse’s relational learning in the current experiment.

Köhler outlined transposition as a process that resulted in a form or stimulus being reacted to similarly regardless to changes in color, size and location (Köhler, 1929). He explained that these stimuli will be treated the same regardless of changes made and that they can be transposed. Lashley has been credited with being the first to find that when animals are trained to react positively to one of two stimuli, the animals reaction will shift when two new stimuli of the same class are presented, and the new positive reaction will be directed towards the stimulus that plays the same role in the new pair as the original pair (Köhler, 1929). Köhler went on and tested this idea, which he called Transposition, on chicks. He trained a chick with two gray squares, squares I and II, with II being darker then I. He trained the chick to reliably choose II, the darker of the two gray squares (Köhler, 1929). After the chick reliably chose the darker II grey square, he introduced a new even darker square, III. Köhler believed that the chick would have learned a relational concept, pick the darker, and predicted that the chick would now pick the new darker of the two stimuli. When the gray II and the new darker gray III were presented, in the majority of the trials the chick chose the new darker gray III (Köhler, 1929). II was considered the “dark side” of the first pair, then in the new pair, III assumed that role, and since the animal learned to choose the dark side of the pair, it avoided the specific gray it originally learned to choose and chose the new darker gray after transposition (Köhler, 1929). In the original pair, the chick was trained to positively respond to the darker square. When the new darker square was presented, a stimulus from the same class, the chick's reaction was directed towards the new darker stimulus as it now played the same role in the new pair as the gray II did in the original pair. The new gray III was the darker square in the pair so the chick shifted towards this new stimuli. Köhler hypothesized that transposition occurred because animals treat the stimuli as wholes as opposed to pairs, which are dependent upon each other and each have definite characteristics which depend upon each stimuli's position in the whole (Köhler, 1929). Köhler believed that the subjects had learned a relational concept and that the subjects learned a relationship between the stimuli instead of treating each stimuli as an independent form. The subjects treated the stimulus as a whole and learned the relationship within that whole. This current experiment aimed to test Köhler's transposition concept with horses.

Previous research conducted by Gulliksen (1932) has tested the idea that relational cues impact decision making. In his study, he trained 12 rats to react positively to one of two circles, either 6cm or 9cm in diameter. Six of the rats were trained to react positively to the 6cm circle and the remaining 6 were trained to respond positively to the 9cm circle (Gulliksen, 1932). He then tested the rats using circles of various sizes. Test pairs used circles with diameters: 13cm vs. 9cm, 6cm vs. 4cm, 7.5cm vs. 5cm, and 18cm vs. 12cm. Results from these pairing showed that only during the 7.5cm vs. 5cm test did all the animals react on the basis of relational cues. The other test pairs led to significantly less subjects responding relationally, and the remaining animals responding to absolute cues or simply chance. The results of this study demonstrated that when absolute rules are cut out, a clear reaction to relationship is given by the majority of animals but only when there is a slight deviation from the training situation (Gulliksen, 1932). He found that rats can respond based on relational cues but only when the test stimuli only slightly deviate from the training stimuli. When greater deviations from the training stimuli were presented, individual differences in the way each rat solved the problems became more evident.

As well, Feeney (2003) conducted a similar study with rats and based her experiment on the work of Gulliksen. In her study, Feeney aimed to further examine the influence of stimulus equivalence, absolute cues, and relational factors on transposition behaviors. The study used a T-maze with stimuli mounted on the doors of the goal boxes. She trained 8 rats to discriminate between either a pair of circles or a pair of triangles of different sizes. In each case, the medium sized stimulus was always the S+. Two rats in each shape group were required to choose the side with the larger stimulus, and two required to choose the side with the smaller stimulus (Feeney, 2003). The cues were randomized (left or right arm of the maze) by the experimenter. The rats were required to perform consistently or to show marked improvement during this training phase and if they did not learn the original training paradigm during the time given, they were not included in the test phase. During the test phase, on the majority of the trials the training pair was presented and during one out of every six trials a probe trial was added (Feeney, 2003). Probe trials involved three possible test pairs. The possible probe trials were; one probe trial the test stimuli were different pairs of circles or triangles (whichever shape had been used in training), second probe trial was the positive stimulus from the training pair and a triangle (if the original pair had been circles and vice versa for triangles), and the third probe trial was either two circles or two triangles, whichever was not used in training (Feeney, 2003). The probe trials were randomly sequenced and the location of the stimuli was controlled by the experimenter. Results from this experiment were ambiguous and found that only on probe pair B did rats respond 'relationally'. The results from this study did not necessarily support the concept of transposition. Both experiments tested discrimination learning through transpositions paradigms based on relative size concepts. The current experiment attempted to perform the exact same experiment except with different subjects, slightly different stimuli, and a different apparatus. The underlying design of Feeney (2003) and Gulliksen (1932) was used with some slight changes.

Previous discrimination learning based on relative size concepts has been conducted with horses. Hanggi (2003) explored whether horses could respond to stimuli using a concept based on relative size. The original training required the horses to discriminate the larger S+ item in a pair of stimuli for six sets of two-dimensional training exemplars (Hanggi, 2003). Prior to training the horse was given a preference test and chose the smaller of two circles, therefore the larger circle was designated the correct S+ (Hanggi, 2003). Each stimulus consisted of four sizes, with each item being either one-half bigger or one-half smaller. During training, the horses was presented pairings of large versus medium, medium versus small, and small versus tiny simple two-dimensional stimuli such a squares and triangles. After training occurred and the horse responded above chance for most of the stimulus pairings, a single horse was tested for size transposition. The size transposition testing used novel larger and smaller stimuli as well as three-dimensional objects (Hanggi, 2003). Novel, more complex 2D and 3D stimuli such as a ball and a plate were now used to test for relational concept learning. Two more horses were later tested and used a subset of the stimuli used in the first experiment. Transposition tests confirmed that the horse responded on a relative basis and indicated that at least some horses are capable of relative concept learning (Hanggi, 2003). Concept learning was further tested by pairing novel two-dimensional and three-dimensional stimuli. The results showed that the horse responded equally well for 3D and 2D shapes (Hanggi, 2003). The research showed that horses were able to learn a relational concept amongst multiple pairs of two-dimensional and three-dimensional stimuli which included items such as flat black PVC pipe connectors, different color balls, and flower pots. The horses consistently chose the appropriate stimuli, whether the task involved choosing the larger or the smaller of the pair and this implied that they were attending to some form of concept and not simply learning through trial and error (Hanggi, 2003). This research showed that horses have the ability to respond relationally during discrimination tasks and the current experiment aimed to test this idea further with different transposition tests and different stimuli.

The experiment was designed to test the hypothesis that horses could learn a relational concept and successfully apply it during discrimination tasks. Horses will successfully learn to 'pick the bigger' of two stimuli and apply this rule to both shapes it has never seen before and different size relations. The experimenter aimed to determine if horses could transpose.

Method

Subjects

The subjects in this study were four horses (Equus Caballus) that varied in weight and age. Subject one was a 20 year old Arabian X Quarter horse X Appaloosa mare named Dancer, with a weight of 498.95 Kg and a height of 154.94cm. This subject arrived at Victory Horse Park in 2004 and was an English riding horse. The subject was ridden four times during the nine days the experiment was conducted. The horse was housed outside in a 45.72m x 182.88m fenced grass pasture. A 1L Fortex Heavy Duty rubber pail was placed in the pasture twice a day and held a combination of 226.79g of Nature Feed regular oats produced by Nature Feed Centre Inc. in Burgessville, ON and 226.79g of Purina Evolution Senior Multi-Particle senior horse feed produced by Agribrands Purina Canada Inc. in Woostock, ON. 6.80Kg of second-cut local Alfalfa hay was also placed in the pasture twice a day with the grain

Subject two was a 30 year old Standardbred gelding named Keysto, with a weight of 362.874Kg and a height of 152.4cm. The subject arrived at Victory Horse Park in 1997 and was a retired race horse. The horse was housed outside in a 45.72m x 182.88m fenced grass pasture. A 1L Fortex Heavy Duty rubber pail was placed in the pasture twice a day and held a combination of 226.79g of Nature Feed regular oats produced by Nature Feed Centre Inc. in Burgessville, ON and 226.79g of Purina Evolution Senior Multi-Particle senior horse feed produced by Agribrands Purina Canada Inc. in Woostock, ON. 6.80Kg of second-cut local Alfalfa hay was also placed in the pasture twice a day with the grain. This subject had not been ridden for several years.

Subject three was an 8 year old Thoroughbred X Oldenberg named Cheese, with a weight of 635.0293Kg and a height of 175.26cm. The subject was born at Victory Horse Park in 2007 and was an English riding horse. The horse was housed outside in a 45.72m x 45.72m fenced grass pasture. A 1L Fortex Heavy Duty rubber pail was placed in the pasture twice a day and held a combination of 680.38g of Nature Feed regular oats produced by Nature Feed Centre Inc. in Burgessville, ON and 680.38g of Purina Evolution Senior Multi-Particle senior horse feed produced by Agribrands Purina Canada Inc. in Woostock, ON. 27.21Kg of second-cut local Alfalfa hay was also placed in the pasture twice a day with the grain. This subject had not been ridden for several months.

Subject four was a 12 year old Thoroughbred x Dutch Warmblood named Potatoes, with a weight of 544.31Kg and a height of 170.18cm. The subject was born at Victory Horse Park in 2003 and was an English riding horse. The horse was housed outside in a 60.95m x 121.92m fenced grass pasture. A 1L Fortex Heavy Duty rubber pail was placed in the pasture twice a day and held 1360.78g of Equiline Pelleted All-In-One Ration made by Shur-Gain in Burford, ON. 27.21Kg of second-cut local Alfalfa hay was also placed in the pasture twice a day with the grain. This subject had not been ridden for several months.

All horse pastures were fenced with 3.81cm Poly Tape by Safe Fence and 182.88cm long, 15.24cm diameter cedar fence posts. Two 1L Fortex Heavy Duty rubber pails filled with well water were also placed in each pasture and the horses were fed twice a day at 8 A.M. and 3 P.M.

All subjects feed remained the same throughout the entire experiment and was not altered in any way. All subjects were on ad lib water at all times. The horses were up to date on their vaccinations which included Rhinoflu, rabies, tetanus, West Nile, and Eastern & Western encephalitis. None of the subjects required medical care during the experiment. None of the subjects underwent any experimental procedures prior to the one described and the horses were consistently tested at 3 p.m in the afternoon for 9 consecutive days.

Apparatus

A 165cm tall test apparatus was used to test the subjects. A 122.5cm tall wooden bicycle stand was used as the base of the apparatus. A wooden box was then screwed onto the top of the bicycle stand. The face of the box was 43cm tall by 66.5cm wide and had two 20 cm wide, 30cm tall doors cut into it. The top of the doors was 11cm from the top of the box and the outer sides of the doors were 8.5cm from the side edges of the box. The doors were cut 10cm apart from each other. The bottom of the door was 124cm from the ground and the top of the door was 166cm from the ground. The side walls of the box were 40cm wide by 43cm tall and the top and base of the box had dimensions of 66cm long and 40cm wide. The back wall of the box was

14cm tall by 66.5cm wide. A 20cm wide, 25cm tall wood divider was attached to the backside of the face of the box, inside the box. The divider was located between the two doors, 4.5cm from each opening. Two metal hooks were screwed above each door. The hooks were 10cm apart, 5.5cm from the top of the box, 4cm above the door, and 5cm from each side of the doors. Six 20cm wide 29cm tall doors were constructed from 3mm thick recycled cardboard. Two 13mm in diameter holes were cut into the cardboard. The holes were located 10cm apart, 2cm from the top of the cardboard door, and 5cm from each side. Three of the cardboard doors had circles drawn on them and the other three cardboard doors had squares drawn on them. The areas of the shapes increased by a ratio of two, 1:2:4. The circles had diameters of 6cm, 8.46cm, and 11.98cm respectively and the squares had lengths of 6cm, 8.49cm, and 12cm respectively. All of the shapes were located in the center of the cardboard doors and were drawn on with a Sharpie Fine Point black permanent marker. Carrots were cut into approximately 20g pieces and were used to bait the apparatus. The entire apparatus was placed outside of a horse stall in a central alleyway in the horse barn. The stall had the dimensions of 284.48cm in width and 317.5cm in length. The back and side walls were made from cedar planks. The front wall and door of the stall were both made from cedar planks and steel bars. The lower 121.92cm of the front wall and the door was made from cedar planks and the top 121.92cm was made from 2.54cm thick steel bars. The steel bars were spaced 7.62cm apart and were painted black. The front of the stall was divided equally into a door and a front wall. A 92.71cm wide, 58.42cm tall window was located 21.59cm from the roof, 193.04cm from the floor, 88.9cm from the left wall, and 99.06cm from the right wall of the stall. A 1.27cm black rubber matt covered the entire floor of the stall. One 78L bag of McFeeters ultimate quick bedding all natural softwood shavings was unevenly distributed over the stall floor. The ceiling of the stall was yellow. All buckets were removed from the stall prior to testing.

Figure 1. Stimuli used in training.

Figure 2. Apparatus with training stimuli in place.

Procedure

All horses were given a number of pre-training sessions. On the first day, the apparatus was placed in the stall with the horse and the horse was allowed to explore it. On the second day, the apparatus was baited without any doors. Again the horse was allowed to explore it until it placed its nose inside the box and found the carrot bait. The apparatus was re-baited and the horse was allowed to continue finding the bait until the horse appeared comfortable placing its nose inside the box. On the third and fourth day, a cardboard door without any shape was placed in the door cut outs in the face of the box. Both doors were baited and again the horse explored the apparatus. The experimenter shaped the horse's behavior by first rewarding the horse for placing its nose near the cardboard door, for nosing it, and finally for pushing the door open with its nose. This training was continued until the horse consistently pushed the cardboard door open on its own and found the carrot bait.

During the training phase the horses were required to discriminate between either a pair of circles or a pair of squares. All horses were required to choose the door of the apparatus that had the larger shape on it. Table 1 presents each subjects assigned shape and training pair. Correct choices were rewarded with carrots. Both doors on the apparatus were closed until the horse's choice had been made.

The experimenter controlled the location of the stimuli (left or right of the apparatus) by using a 1- 10 number generator. When an even number was generated, the larger shape would be placed in the right door of the apparatus, when an odd number was generated, the larger shape would be placed in the left door of the apparatus. The horse was place in the stall and the door was closed. The apparatus was then placed in front of the stall door in the middle of the door and the door was opened. The experimenter held the horse back from the apparatus until the apparatus was moved into the doorway and then the horse was released and the experimenter left the stall and stood behind the test apparatus. Correct and incorrect first choices made by the horse were recorded. After the horse made its choice, correct or not, the apparatus was removed from the stall and the door was closed. The apparatus was moved to an area of the barn where the horse could not see it and was re-baited and the stimuli were changed for the next trial. Five trials were run in one session. Twenty training trials were completed over four consecutive days.

Results

A choice of shape was noted when the horse nosed or pushed the door of the apparatus open, regardless of whether the horse ate the carrot bait. A correct choice was noted when the horse nosed or pushed open the apparatus door that had the larger shape on it during each trial.

Table 1.

Stimulus pairs (Shapes and Sizes)

Subject	Training Stimulus	S+	S-
1	Medium/Large Squares	Large square	Medium square
2	Small/Medium Squares	Medium square	Small square
3	Medium/Large Circles	Large circle	Medium circle
4	Small/Medium Circles	Medium circle	Small circle

Note: Subjects always picked the bigger shape in each pair

An incorrect choice was noted when the horse nosed or pushed open the apparatus door that had the smaller shape on it during each trial. Both correct choices and incorrect choices were recorded. After 20 trials the total number of correct choices was calculated and the results of training were examined. The results of training are shown in Table 2. A chi squared goodness of fit was completed and no statistically significant results were found. The horses did not appear to have learned the relational concept ‘pick the bigger’.

Discussion

The results of this experiment did not support the hypothesis that horses could learn a relational concept and successfully apply it during discrimination tasks. The horses did not successfully learn to ‘pick the bigger’ of two stimuli. Transposition testing through probe trials never occurred because the horses did not learn their relational concepts during training. The horses were never tested on shapes and size relations they had never seen before as the experiment was terminated after training. The experimenter concluded that horses could not transpose.

After the experiment was performed, a few methodological problems were noted. It was noted that there were secondary cues on the training cards such as scratches, horse saliva and mucus, dirt, and hair that the horses could have responded to, and not the size of the circles or squares. Gulliksen (1932) noted that after the animals had been given several tests the cards used in the training series they had scratches, smudges, ect. It was possible that the animals were responding to the secondary cues and not the sizes of the squares and circles. The horses sniffed and get mucus on the test cards and both the medium circle and square were shared between a pair of horses (i.e., one stimulus pair was Small/Medium squares and another was Medium/Large squares). The horses could have responded to test cards because of the smells and scratches the

Table 2. Training Data and Chi-Squared Results

Subject	Total number of correct choices	Chi Squared Value	Significant or Not
1	16	3.6	Not significant
2	7	0.9	Not significant
3	8	0.4	Not significant
4	10	0	Not significant

Note: Total number of correct choices is all correct choices made during all 20 training trials other horse had left on it during previous training sessions. This was potentially a serious methodological flaw the experimenter had not anticipated. This flaw could have led the horses to ignore the shapes and instead focus on the smells and scratches left by other horses. This could have explained why many of the subjects chose so sporadically throughout the training sessions and could explain why the horses did not appear to have learned a relational rule of ‘pick the bigger’. The secondary smell stimuli could have thrown the horses off and they may have been more drawn towards the scents then the shape size. This problem could have been avoided if the experimenter had of created sets of training cards for each individual horse and was a potential improvement that could have been made.

Another potential methodological issue was the constant noise and different horses in the barn when training occurred. People would walk through, different horses would be in the barn, and dogs barked constantly throughout training. There was always different sounds and different animals around that could have distracted the horse. The horses’ attention could have been drawn away from learning the relational rule because of the distractions that occurred in the barn. This was a serious methodological flaw that the experimenter had a difficult time controlling for. The experimenter asked that the barn be empty when testing occurred and that the dogs be shut out of the barn but this was difficult. Because the barn boarded horses, it was difficult to ask all of the owners to avoid the barn during a certain time of the day. As well, the dogs were not allowed to be let outside unsupervised and the owner was not always available to watch them. This caused for the dog barking to be unavoidable. This was a methodological flaw that the experimenter had a difficult time controlling.

Another potential methodological flaw was that animals could have been responding based on absolute cues. Brezinsky & Pepperberg (1991) suggested that one major problem in discrimination tasks is that unlike humans, animal subjects appeared to respond preferentially on an absolute basis. The horses could have simply learned a single association or habit in terms of what side of the apparatus they chose. Several horses in the experiment preferred the right door of the apparatus and continually chose it. The experimenter attempted to control for this problem by varying the spatial location of the stimuli. This was done to make sure that the horses learned the relational concepts ‘pick the bigger’ and did not learn to simply pick one side of the apparatus or develop a habit of picking on side of the apparatus. Horses are habitual animals so this was something the experimenter closely monitored. A number generator was used to vary the spatial location of the stimuli when training occurred. However, at times multiple odd numbers or even numbers were generated in a row. This was a potential confound because this gave the horse an opportunity to learn a specific side of the apparatus and respond based on absolute cues as opposed to learning the shape. This was another potential methodological issue as the horse still could have developed a habit of picking one side of the apparatus.

Overall the horses did not learn the relational concept ‘pick the bigger’ when training occurred. They picked sporadically throughout all 20 training trials and made no indications they had learned anything about the relationships between the shapes. One subject made a significant number of correct choices and appeared to have learned something about the relational rule. However, a chi squared goodness of fit test indicated that the subject’s number of correct choices was not enough to be significant and she too had not learned the relational rule.

Individual differences was a potential explanations for why the horses performed as differently as they did. Each individual horse could possess different cognitive abilities which could explain why some horses did make more correct choices than others. One subject made significantly more correct choices than other subjects and there was some variation in the number of correct choices made between the other three subjects. The subject who did the best, Dancer, could have better cognitive abilities compared to the other subjects which would have explained why she did better on the discrimination tasks. However, overall it appeared that that they based their choices randomly and very sporadically and individual differences did not appear to play a huge rule in performance.

The data from the current study and the data from Hanggi (2003) have contradicted each other. The results from the current study suggested that horses cannot learn relational concepts and respond relationally when completing discrimination tasks. However, the results from Hanggi (2003) suggested that some horses do have the ability to learn relational concepts when completing discrimination tasks based on relative size. Future research needs to be done to clear up this contradiction. As well, more research needs to be done to determine if the test stimuli itself impact performance on discrimination tasks. For example, are transposition tasks easier when the shapes are three-dimensional compared to two-dimensional? Does performance increase when three-dimensional shapes are used? Overall, is discrimination learning easier when three-dimensional or two-dimensional shapes are used? Overall, more research needs to be conducted to determine if horses can respond relationally during discrimination tasks when the tasks are based on size and to determine if they do have the capacity to learn the relational rules and transpose.

References

Brezinsky, M. V., & Pepperberg, I. M., (1991). Acquisition of a relative class concept by an african gray parrot (psittacus erithacus): Discriminations based on relative size. *Journal of Comparative Psychology, 105*(3), 286-294. doi:http://dx.doi.org/10.1037/0735-7036.105.3.286

Feeney, M. (2003). *An Examination of Discrimination Learning Patterns in Rats as seen through the Extensions of a Transpositional Paradigm*. London, Ontario: The Huron University College Journal of Learning and Motivation, 40, 75-100.

Ferguson, G. (1976). *Statistical Analysis in Psychology & Education* (4th ed.). McGraw-Hill.

Gulliksen, H. (1932). Studies of transfer of response: I. relative versus absolute factors in the discrimination of size by the white rat. *The Pedagogical Seminary and Journal of Genetic Psychology, 40*, 37-51. Retrieved from http://search.proquest.com/docview/614990915?accountid=15115

Hanggi, E. B. (2003). Discrimination learning based on relative size concepts in horses (*equus caballus*). *Applied Animal Behaviour Science, 83*(3), 201-213. doi:http://dx.doi.org/10.1016/S0168-1591(03)00136-9

Köhler, W. (1929). *Gestalt Psychology*. New York: Horace Liveright Inc.