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The use of a T-maze to measure cognitive-motor function in cats (*Felis catus*)

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Abstract

Few tests have been developed to test the cognitive and motor capabilities of domestic cats, in spite of the suitability of cats for specific studies of neuroanatomy, infectious diseases, development, aging, and behavior. The present study evaluated a T-maze apparatus as a sensitive and reliable measure of cognition and motor function of cats. Eighteen purpose-bred, specific-pathogen-free, male, neutered domestic shorthair cats (*Felis catus*), 1-2 years of age, were trained and tested to a T-maze protocol using food rewards. The test protocol consisted of positional discrimination training (left arm or right arm) to criterion followed by two discrimination reversal tests. The two reversal tests documented the ability of the subjects to respond to a new reward location, and switch arms of the T-maze. Data were collected on side preference, number of correct responses, and latency of responses by the subjects. Aided by a customized computer program (CanCog Technologies), data were recorded electronically as each cat progressed from the start box to the reward arm. The protocol facilitated rapid training to a high and consistent level of performance during the discrimination training. This learning was associated with a decrease in the latency to traverse the maze to a mean of 4.80 ± 0.87 s indicating strong motivation and consistent performance. When the rewarded side was reversed in the test phase, cats required more trials to reach criterion, as expected, but again showed reliable learning. The latency to reward in the first session of reversal increased 86% from the first to the last trial indicating that it may provide a useful index of cognitive processing. Latencies subsequently

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decreased as the new reversal paradigm was learned. This paradigm provides a relatively rapid and reliable test of cognitive motor performance that can be used in various settings for evaluation of feline cognitive and motor function.

Keywords

Feline; cognition; cognitive-motor function; T-maze; feline immunodeficiency virus

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1. Introduction

There is a paucity of quantitative information available on cognitive and motor function in domestic cats, despite the fact of their domestication over millennia and their ubiquity as pets. Although the utilization of cats in neurobiological studies is well documented, their use in cognitive-motor assessment paradigms is widely viewed as challenging. Sensitive and reliable measures of cognition (Dore et al., 1996) and motor function in cats could provide valid and sensitive endpoints for studies of feline aging (Levine et al., 1987), diet, and disease states. We have been particularly interested in utilizing cognitive and motor tests to distinguish behavioral effects of feline immunodeficiency virus (FIV), aiding in our understanding of the pathophysiology and pharmacologic management of the disease (Meeker, 2007). For example, FIV serves as an important animal model for human immunodeficiency virus (HIV), including neurologic dysfunction seen in both diseases. In spite of progress in the development of retroviral treatment agents, cognitive decline remains a persistent and debilitating problem among HIV-infected individuals (Moore et al., 2011; Robertson et al., 2007; Sacktor et al., 2002). However, although of critical importance, early, subtle behavioral effects of the disease in cats have not been fully addressed, limiting the ability to investigate early interventional therapies.

Several recent studies have attempted to reveal cognitive and motor abilities of cats, with mixed success. For example, a hole-board test was developed as a spatial memory test for cognitive ability to distinguish feline immunodeficiency virus (FIV)-infected from uninfected cats (Steigerwald et al., 1999). A simplified version of the test has also been applied to aging studies but may not be sensitive enough to identify effects of aging on cognitive function in cats, if they exist (McCune et al., 2008). Cats failed to “show causal understanding” in a string-pulling task (Whitt, 2009) or to distinguish two from three dots in a quantity discrimination test, although alternative explanations were suggested (Pisa and Agruillo, 2009). Feline motor function has been evaluated using a plank-walking test (Steigerwald et al., 1999). This test revealed motor differences between cats infected as kittens with FIV and uninfected controls but did not identify aging effects on motor function in cats (McCune et al., 2008), leading to uncertainty about the sensitivity of the test. More recent tests have employed increasingly sensitive measures of cognitive and motor function in FIV infected cats. Increases in gait width, greater errors in a stepping task and increased maze completion times in a modified T-maze were found to correlate with inflammatory markers and CNS FIV viral burden (Malingat et al., 2009). These studies reveal the potential of behavioral studies to assess neural function in cats but also highlight the need for more sensitive and standardized approaches.

The goal of these studies was to develop a simple yet sensitive test that could be used for the assessment of disease-associated cognitive-motor decline as well as the efficacy of novel therapeutic agents. The T-maze has been used as a standard tool for the assessment of cognitive processes (Haley and Raber, 2011), such as spatial memory and associative learning, as well as motor function in many species, from mollusks (Painter et al., 1998) to rats (Carillo-Mora et al, 2009) to primates (Easton et al., 2003). In cats, Levine et al (1987) utilized the T-maze to examine the effect of aging in cats. The T-maze has also been used in feline ablation studies to document limitations to sensory discrimination and spatial learning (Burgess et al 1986, Norrsell 1983). The objective of the present study was to develop a reliable and sensitive T-maze protocol which could be used to quantify cognitive and motor function in cats.

2. Materials & Methods

2.1 Subjects

The subjects were 18 specific-pathogen-free (SPF), purpose-bred, neutered male domestic short hair cats (*Felis catus*) between 1-2 years of age. The cats were maintained in individual pens (188 cm high, 147 cm deep, 91 cm wide) in a laboratory animal facility on a 12/12 light–dark cycle, fed a measured balanced feline dry ration after testing each day, and maintained at body weights consistent with initial body weights and low-normal (3/9-4/9) body condition score, as referenced on a standard score chart (Purina Body Condition Score Index, http://www.purina.com/cat/weight-control/bodycondition.aspx). At the time of initial training, all cats were naïve to cognitive testing. Housing and test protocols were approved by the North Carolina State University Institutional Animal Care and Use Committee.

2.2 Apparatus

Constructed of plywood sealed with polyurethane to conform to laboratory standards, the feline-adapted T-maze was designed by CanCog Technologies to provide a simple test of cognitive and motor ability (Figures 1 & 2). The outside dimensions of the T-maze were 183 cm x 99 cm, with a height of 77 cm. The maze components included a start box which opened to a runway at the end of which was a decision point, and a left and right reward arm, each leading to a reward area with a reward well where a food reward could be placed. Doors, positioned in each reward arm, were closed to prevent path reversal after the arm choice was made. These doors had magnetic latches which kept the doors open and could be remotely closed by the tester via a switch which released the magnet once the cat had passed. Doors out of and into the start box were guillotine style, operated manually by the tester. Partial wooden panels obscured the view of the reward well until the cat had committed to entering a reward arm and passed the threshold for door closure. Each reward area was directly connected to the start box. Thus, at the end of each trial, subjects were able to directly enter the start box from either reward area, when a connecting door was raised. Fitted acrylic sheets covered the top of each section of the maze to prevent escape but allowed the animals' behavior to be continuously observed. The tester sat on a stool adjacent to the start box, positioned at the middle point, and could visualize the cat but did not provide cues or interact with the subject. Special vertical tracts permitted the insertion of partial impediments to the path of travel, such as partitions (weaves), or low or high hoops, used to increase motor difficulty after the maze paradigm was learned. A specific computer program (CatCog) was developed by CanCog Technologies to record number of correct choices and latency to response (in milliseconds). The computer was positioned outside the cat's range of view from within the box. The start and end of the timer as well as the closing of the reward arm doors were manually controlled by the experimenter. The order of testing was randomized daily. Inter-tester reliability by the three trained testers was evaluated regularly during the study using video recordings of tester performance.

2.3. Behavioral Conditioning

Using food rewards, cats were conditioned to handling and transport using reward-based training. Transport consisted of voluntary entry into a standard commercial cat carrier and transport to a behavioral test room, and return via carrier after testing. When cats were fully conditioned to the carrier and transport, serving as voluntary participants, the T-maze was introduced. In addition, during this process, the cats became familiar with those human individuals who performed the T-maze test protocol. Those individuals did not participate in restraining, anesthesia, surgery or sample collections, a fact that we consider important in reducing fear responses and optimizing cooperation on the part of the test subjects. Food motivation was high; rations were reduced during testing to induce some hunger but maintain weights within 90% of baseline weights. Cats were trained and tested from 0800-1100 hours using highly palatable food rewards (Pounce® cat treats, Del Monte Foods; Whiskas® cat treats, Mars, Inc; various flavors) and were fed a measured ration of dry chow based on body weight after testing at 1500 hours.

2.4. T-Maze Protocol

The test protocol had previously been developed by CanCog Technologies (unpublished data) and consisted of 6 stages: Adaptation, Reward approach, Preference testing, Discrimination training, Reversal 1, and Reversal 2 (described below). Cats were tested 6 days per week by technicians that were both familiar to and with the cats during the behavioral conditioning period. The maze was cleaned with a neutral-odor disinfectant (Trifectant®, Virkon Corporation) between sessions and left to air-dry.

2.4.1. Adaptation and reward approach—Adaptation allowed the cats to become familiar with the configuration of the T-maze and to be rewarded for exploratory motor behaviors. The duration of each adaptation session was variable, ranging from 10-15 minutes once daily, depending on each cat's responses. Small food rewards were strewn throughout the maze, all doors in the maze were fixed open, and each cat was placed in the maze at the start box. After the initial sessions, as the cat moved through the maze purposefully, the maze doors, including those to the start box, were opened and closed manually by the experimenter to acclimate the cats to the sound and associated air movement. Enough time was allowed for each cat to fully explore the maze each day and receive food rewards from left and right reward arms. The criterion for each cat's completion of the adaptation stage was when the subject would reliably move throughout the maze, from the start box to both reward arms, and ingest treats 10 times in one session. The number of days required for this stage was variable due to the behavioral qualities of each cat: more timid or reactive cats required more time to adapt to the apparatus and behavioral protocol.

Reward-approach involved reducing the number of treats placed in the maze, with treats always present in both reward wells at the far end of the reward arms. As the cat progressed with the process of moving through the maze, the technician began to require the cat to wait in the start box before being released into the rest of the maze to pursue a route to one reward well. Eventually, treats were restricted to the reward wells of both arms of the T-maze and high hoops were positioned in the maze for all subsequent trials. Two high hoops were placed in the runway and one high hoop was placed in each arm in order to increase the motor difficulty of the task. High hoops were 75 cm solid barriers with a 21 cm diameter round opening with the bottom of this opening set at 40 cm height. These were used in the discrimination training and reversal tests presented here since we had determined in pilot studies that high hoops increased the motor challenge and significantly affected latency times. In spite of rewards being present in both reward wells during the reward approach phase, cats naturally began to show a directional preference, choosing one side more frequently than the other (typically the first rewarded side). The side preference was not uniform among cats, with some showing preference for the left side and some for the right side. Completion of the reward-approach phase was when the cat would traverse the maze successfully from start box to either reward arm 10 times in one session with the high hoops in place and food rewards located only in the reward wells.

2.4.2. Preference testing—Following successful completion of the reward-approach stage, each cat had one day of preference testing to determine its preferred side. This was established empirically as the side that a cat went to ≥6 times during one session of 10 trials, when both arms contained rewards. A contingency was planned for cats that did not show a preferred side (5/5 split) such that their preferred side would be determined by a 2/3 coin toss; however, this was not needed. Each cat's preferred side was utilized by default as the first rewarded side in Discrimination training to facilitate and standardize the initial reward training. Using each cat's preferred side allowed us to establish a strong response pattern prior to the introduction of Reversal 1 and Reversal 2. Establishing consistent performance was an important consideration since individual variation in performance is often a limiting variable in attempts to establish reliable test paradigms.

2.4.3. Discrimination training and Reversal 1 and Reversal 2 tests—The general protocol for Discrimination training and Reversal 1 and Reversal 2 tests was as follows: the test cat was positioned in the start box and the tester started the software timer the instant the cat was released (when the door out of the start box was opened), then stopped it the instant all four feet of the cat crossed a pre-determined point in either reward arm (Figure 1, location E). When stopped, the software began a 30-second inter-trial interval which allowed the cat time to ingest the reward and return to the start box (Figure 1, location A), and for the tester to reset the rewards in the reward arms. To control for auditory cues, the tester lifted the doors on both the left and right reward arms and placed a reward into the empty reward well then closed both doors. Each cat completed a total of 10 trials (1 session) per day. On each day of testing, cats were rewarded on only one side of the maze for the entire session of 10 trials. After the first error in side choice, cats were allowed to traverse the maze to the other (rewarded) side, however subsequent errors were not followed by an opportunity to correct direction and reward arm doors were closed. Latency was recorded by the proprietary software (CatCog) as the time from opening the door to the start box until the back legs passed the threshold of the reward arm door. Cats had 60 seconds to complete the maze or were recorded as a non-response for that trial. These trials were not included in the latency calculations. For analysis, a ceiling of 20 seconds (s) was placed on the latency measure to minimize skewing of the data. During the Discrimination training, the reward was located on the cat's preferred side, and this was then alternated for Reversal 1 and Reversal 2.

To assure consistency in performance while leaving some flexibility for daily variation, cats were tested for a minimum of four days and a criterion of 21/30 correct responses on three consecutive days was used in order to advance to the next phase. This was because pilot studies indicated that an individual cat's performance may be variable from session to session. For example, 10/10 correct on one day may be followed by 8/10 correct on a subsequent day. Thus, criteria for completion of each stage was 9/10 or 10/10 correct on one day, or 8/10 correct on 2 consecutive days, followed by 21/30 correct responses on the following three consecutive days. After the Discrimination training was completed, Reversal 1 stage was initiated by placing the reward in the opposite T-maze arm. Reversal 1 was followed by Reversal 2 with the reward returned to the original, preferred arm of the T-maze. For each cat, the following measures were collected: preferred side (left or right), number of correct responses, number of trials to criteria, and latency to reward arm (in milliseconds).

2.5. Statistical Analysis

Summary statistics [mean ± standard error of the mean (sem)] were calculated for all cats for percent correct responses per session, trials to criterion and latency for each phase of testing (Discrimination training, Reversal 1, and Reversal 2). Descriptive statistics (mean, standard error of the mean) were calculated using Excel worksheets and GraphPad Prism® statistical and graphics software. The data was evaluated for normality using both the Kolmogorov-Smirnov and D'Agostino and Pearson omnibus normality tests. Non-parametric statistics were used for data failing both tests. Changes in performance were assessed using a within subjects repeated measures design. Changes in performance during each of the two reversal tests were compared to discrimination training based on mean number of trials to criterion and a one-way ANOVA across Discrimination training, Reversal 1 and Reversal 2. Session latencies were analyzed with a two-way repeated measures ANOVA to assess changes in running speed within sessions and across conditions (Discrimination training, Reversal 1 and Reversal 2). A t-test was used to compare the mean latency in Discrimination training to the mean latency during the preceding preference testing as well as for the comparison of latencies at the beginning and end of the first reversal sessions. In addition, the latency changes during the first sessions of reversal were evaluated using a regression analysis of latency versus time to determine if the slopes were non-negative.

3. Results

3.1. Adaptation & preference testing

A total of 18 cats were trained to the T-maze. All cats successfully completed training and efficiently traversed the T-maze with high hoops. Adaptation time varied between cats with 4 to 14 days required to begin formal testing (preference test); mean adaptation time (± sem) was 7.8 ± 0.8 days. During preference testing, as a group, the cats failed to show a consistent side preference with left and right preferences equally split (9/18). However, for individual cats, the side preference was relatively strong, with mean 8.78 ± 0.33 responses to the preferred side (t-test; t=11.45 N=18; $p<0.001$ relative to chance). However, when we compared the side preference to the choices made during adaptation there was only a weak relationship with 11/18 cats showing the same side preference and an r^2 of 0.0897 (p=0.227) for the regression of adaptation side preference onto the results of the preference test. This suggested that most cats did not have a strong intrinsic preference to a particular side. The preferred side for 13/18 cats was on the same side as the first rewarded trial suggesting that they may simply continue with the first rewarded response. The mean latency to pass the reward gate was 7.67 ± 0.57 seconds across all trials within the preference test session.

3.2. Discrimination Training and Reversal 1 & 2

Figure 3 illustrates the average number of correct choices out of 10 trials for all cats in each session of Discrimination Training (A), Reversal 1 (B) and Reversal 2 (C). Cats rapidly transferred from the preference session to the discrimination training, showing a mean of 9.18 ± 0.24 correct responses out of ten within the first session. Performance accuracy remained consistently high over subsequent testing. The discrimination criterion was reached in a mean of 4.22 ± 0.13 sessions (10 trials per session) with a range of 4-6 sessions (minimum = 4 sessions). After reversal of the reward to the opposite arm (Reversal 1), response accuracy dropped to a mean of 1.82 ± 0.43 correct in the first session. However, cats quickly adapted to the switch in reward side, showing an average of greater than 90% correct by the third session. During Reversal 1 cats took an average of 5.94 ± 0.23 sessions to criterion. A similar pattern was seen during Reversal 2 with cats taking an average of 5.61 ± 0.20 sessions to reach criterion. These data did not pass tests of normality and were compared using a Friedman non-parametric ANOVA. When compared to the discrimination training, the reversal paradigm resulted in a significant increase in the number of trials required to reach criterion ($p< 0.0001$, n=18, 3 groups, with Dunn’s multiple comparison test of reversal versus discrimination, $p <0.05$). In both cases, the reversal paradigm provided excellent, reproducible learning curves.

3.2.2. Response Latency—T-maze latency provided an independent measure of cognitive processing with excellent sensitivity. In almost all cases, the latency data passed the normality test and parametric statistics were used to evaluate changes unless otherwise indicated. Latency decreased as the cats became more experienced with the maze from an average of 6.86 ± 1.01 seconds during preference testing to an average latency of 4.80 ± 0.47 seconds for the Discrimination training, a significant decrease of 2.1 s (paired t-test, t=2.60, N=18; p=0.0188). Figure 4 illustrates the average latency for each trial across Discrimination training, Reversal 1 and Reversal 2 conditions. Two-way ANOVA across groups and the four matched sessions was applied. A significant effect of session latencies over time (repeated measures) was found (F=6.421, df=3, p=0.004) indicative of a small but continuous decrease in latencies from session to session. No significant effect was seen across conditions (F=1.302, df=2, p=0.281) or interaction (F=0.705, df=6, p=0.646) indicating that the average latencies and patterns and were relatively stable within each condition. However, during Reversal 1, average latency increased 86% over the first session of 10 trials from an initial fast response time of 3.59 ± 0.38 s to 6.69 ± 1.22 s by the end of the session suggesting a delay in response time as the cats began to respond to the reversal. By session 5 of 10 of reversal, average latency was again consistent across the session and reduced to 3.14 ± 0.27 s with a 98.8% arm choice accuracy. During Reversal 2 a similar pattern was seen with latency increasing from a mean of 3.17 ± 0.28 s for the first trial of the session to a mean of 4.64 s ± 0.72 in the last trial. Again, by session 5, cats responded quickly (mean 3.34 ± 0.44 s) and accurately (98.8% correct). To evaluate the potential significance of this trend, we performed a linear regression of latency versus time for each initial reversal session. In each case, the slope of the regression line was significantly non-zero (Reversal 1, F=8.02, p=0.0052; Reversal 2, F=5.426, p=0.0210). The increase was confirmed by comparing the latency of the first trial to the latency of the last trial. The latencies for the last individual trials did not pass normality criteria and the change was evaluated by the Wilcoxin signed rank test which was significant for Reversal 1 (p=0.0069) but not Reversal 2 (p=0.0894).

Although response latencies were generally short, consistent response patterns were occasionally interrupted by a trial with an unusually long latency, often characterized by the subject becoming stationary and exhibiting grooming behavior. Although infrequent, the magnitude of the long latency times contributed disproportionately to the latency variation observed across all trials. The influence of the long latency times can be seen in the trial by trial variation in Figure 3. These long latencies were relatively rare: 4.5% of all trials were greater than 10 s and 1.4% of all trials reached the 20 s limit. Across all trials, the average latency was 4.07 s with a standard deviation of 2.97 s and an upper 95% confidence limit of 9.90 s. By this criterion, a latency of greater than 10 s for any individual cat deviated significantly from the normal latency to run the maze. These deviations were distributed across all sessions (Discrimination Training, Reversal 1, and Reversal 2) but decreased with increased exposure to the maze, not with difficulty of the task. The long latencies (>10 s) were distributed as follows: 16/session in Discrimination training, 9/session in Reversal 1, and 4/session in Reversal 2.

4. Discussion and Conclusion

The findings presented here confirm that cats can be trained successfully on an adapted T-maze that combines both motor and cognitive components. A unique feature of the T-maze design was that the start box was physically connected to the goal box, which allowed repeated testing without having to remove the animal from the maze until testing was complete. After conditioning, individual cats were trained to move from a start box to a decision point, then when the correct arm was chosen, to obtain a food reward. After following a specific training program, all cats (n=18) successfully reached criteria for completion in Discrimination training, Reversal 1 and Reversal 2. Although there was variation in the pattern and rate of learning between cats, the initial Discrimination training was rapid and the group standard errors were low (3-4% of the mean), allowing for the sensitive assessment of changes in the rate of acquisition in subsequent tests.

Use of the cat's preferred side as the initial rewarded side during Discrimination training facilitated consistent and rapid acquisition of the task and, provided an equivalent starting point for all cats. The decrease in latency and the strong performance during Discrimination training indicated that learning had taken place. The cats' initial side preference did not persist during Reversal 1 and 2. During Reversal 1 and 2, cats learned new sides easily and efficiently, suggested that the side preferred during preference testing was not an intrinsic bias.

The cats' speed of running the T-maze became rapid and relatively consistent by the time the Discrimination training was initiated. In each condition, latencies increased in successive sessions but the pattern and average latencies were similar between each condition indicating that performance had stabilized by the beginning of the critical assessments in reversal. The significant increase in latencies over the first sessions of Reversal 1 and Reversal 2, although not a primary variable, suggested that the initial response to reversal may be an important parameter sensitive to cognitive processing for further evaluation in subsequent studies. However, one difficulty was the appearance of occasional trials in which cats appeared to be distracted from the T-maze task. For example, a cat with consistent latencies of 3-6 seconds during 9 of 10 trials in one session, would display a single trial with a latency that was 3-4 times greater than the mean of the other trials. We were unable to identify any environmental or behavioral phenomena to explain this inconsistency. Although these "distracted trials" constituted less than 5% of total trials, they contributed disproportionately to the individual trial variability seen in Figure 4. Further analysis of these "distracted trials" is warranted to determine if these trials might reflect attention deficits or responses to specific stimuli.

A limitation of the T-maze is the difficulty in controlling for olfactory cues, either food odors or feline scent trails that may be present as the cat runs through the maze. While odor of the food reward in the reward area could theoretically influence the cat's decision, the fact that cats show a directional preference when both arms are baited (Adaptation), and do not immediately choose the side with the reward during Reversal learning suggests that this is not the case. It is possible that the cats' own trail through the maze could provide odor cues for themselves. However, during Reversal learning, the cats changed direction during a session as they learned the new direction. The accuracy of responses and excellent learning curve (Figure 3) make olfactory signaling less likely as a confounding explanation. Despite the unlikelihood of olfactory cuing during the testing, in future studies an additional safeguard would be to place a small amount of a food reward hidden underneath the reward well on the non-rewarded side. It is unlikely that cats followed the trails of other cats, since the rewarded side varied between cats and the maze was cleaned between cats and between days.

Decreasing fear responses and behavioral inhibitions were critical to improving motivation leading to a more reliable performance in the T-maze. Although predators, cats exhibit many behavioral adaptations consistent with a prey species, including increased motor behaviors in novel environments, flight reactions to noise and disturbance, and avoidance responses to unfamiliar individuals (Bradshaw 2002). The extent of such responses varies from cat to cat. The protracted conditioning phase of our protocol, including establishing positive experiences with individual technicians was critical to successful testing. In addition, individually customizing the adaptation and reward approach phases of the T-maze was designed to decrease escape responses that could interfere with testing performance.

In all studies of feline cognitive and motor function, maintaining the attention and reward-motivation of the feline subjects is an important consideration in data interpretation. Cats were highly motivated by the food reward and showed no signs of satiation over the course of a 10 trial session. Latencies continued to decrease throughout testing with times of 3-4 seconds typical of trials at the end of Reversal 2. By testing in the morning and then adjusting dry rations for subsequent feeding, each cat could be tested while maintaining a relatively stable body weight.

In conclusion, this study presents a novel, sensitive method of evaluating cognitive and motor function in cats. The adapted T-maze, as presented here, may be applied to studies of feline aging, disease states, and therapeutics to assist the development of new treatment strategies.

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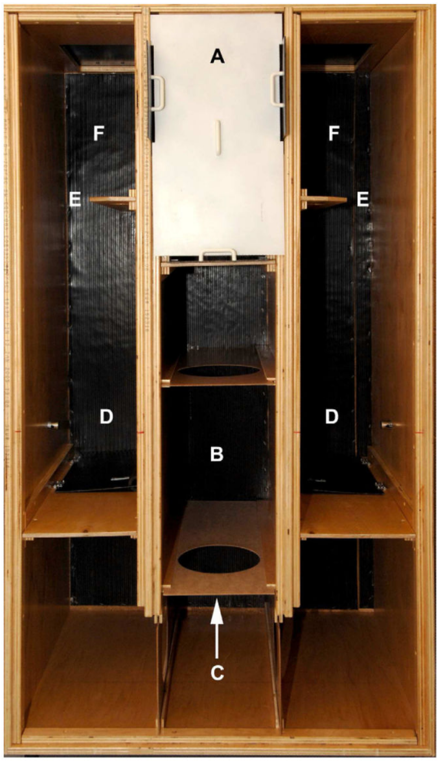

Figure 1.

Feline adapted T-Maze Architecture. Components of the T-Maze: A: Start Box, B: Runway, C: Decision Point, D: Left and Right Reward Arms, E: pre-determined end point, F, Left and Right Reward Area containing reward wells.

Figure 2.

Feline subject navigating high hoops in runway portion of the T-Maze.

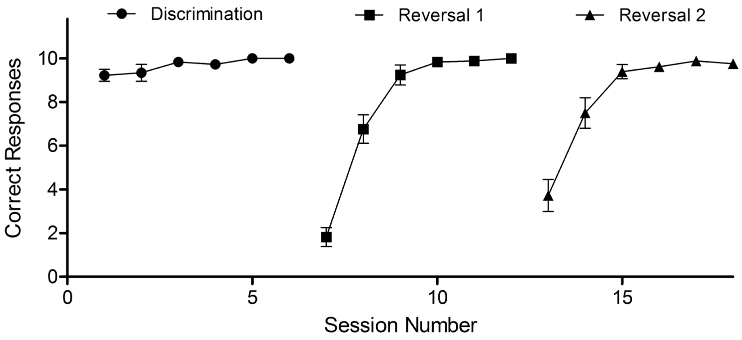

Figure 3.

T-maze acquisition curves for Discrimination Training, Reversal 1, and Reversal 2 for 18 cats. The X-axis represents the session number and the Y-axis represents the mean ± sem number of correct responses per session of 10 trials for all cats.

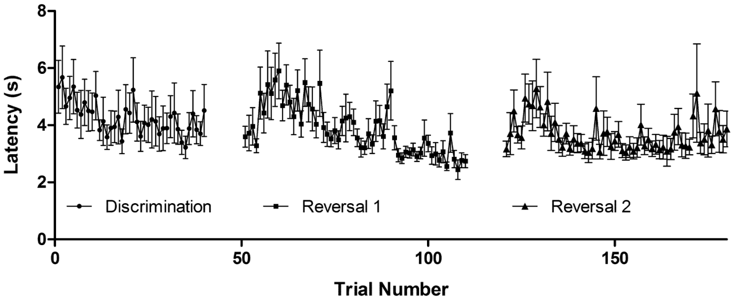

Figure 4.
Latency to T-maze arm choice for each trial during Discrimination Training, Reversal 1 and Reversal 2 for 18 cats. The X-axis represents the trial number (10 trials per session) and the Y-axis represents the mean ± sem latency in seconds to correct choices for each trial.