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Figure Article

Popular Pet Reptile, the Leopard Gecko (Eublepharis macularius), Spontaneously Uses Running Wheel– Is It Locomotion Play?

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Abstract

Play behaviour in non-avian reptiles is poorly understood compared to mammals and birds. No previous reports provide systematic data regarding play-like behavior in the third most popular non-avian pet reptile, the leopard gecko (Eublepharis macularius). Leopard geckos are known to engage with enrichment of novel items, and anecdotal observation by pet owners report high activity and play-like behaviour. An adult leopard gecko kept as a companion animal was provided with a running wheel to formally investigate possible play behaviour. Video recordings and a cycle counter attached to the running wheel were used to create an ethogram of one pet leopard gecko. The animal interacted with the wheel 16% of each measured day, in 11-wheel interaction episodes on average per measured day. The mean total distance measured by the cycle counter was 124 meters per measured day which surpasses the daily movement distance of some similar-sized diurnal lizards. The pattern of results indicates that the leopard gecko's wheel use met all five previously established criteria for locomotion play, and showed that the leopard gecko to sometimes have high activity levels. These data suggest that when kept as a pet, given a running wheel or possibly other enrichment item, small reptiles such as leopard geckos engage in locomotion play. However, further studies with more individuals should be done to confirm this and investigate the possible physiological benefits of exercise.

非鳥類型爬虫類の遊び行動は、哺乳類や鳥類に比べてあまり理解されていない。また、非鳥類型爬虫類の中で、家庭用の愛玩動物として3番目に人気のあるヒョウモントカゲモドキ(Eublepharis macularius)の遊び行動に関する系統的なデータはこれまで報告されていない。ヒョウモントカゲモドキは目新しいものを与えることで興味を示すことが知られており、飼育者による逸話的観察によると、高い活動性と遊びのような行動が報告されている。当研究ではコンパニオンアニマルとして飼育されている成体のヒョウモントカゲモドキに回し車を与え、遊び行動の可能性を調査した。ヒョウモントカゲモドキ1匹のエソグラムを作成するために、ビデオ録画と回し車に取り付けたサイクルカウンターを使用した。その結果、各測定日の16%、1日平均11回の回し車とのインタラクションを行ったことが確認された。サイクルカウンターで測定された平均総距離は1日あたり124mで、これは同サイズの昼行性トカゲの1日の移動距離例を上回るものであった。この結果から、ヒョウモントカゲモドキの回し車の使用は、これまでに確立されているロコモーションによる遊びの5つの基準をすべて満たしており、ヒョウモントカゲモドキは時に高い活動レベルを持つことがわかった。これらのデータは、ペットとして飼育されているヒョウモントカゲモドキのような小型爬虫類に、回し車やその他のエンリッチメント・アイテムを与えることで、ロコモーションによる遊びを行うことを示唆している。ただし、当結果を最終的に結論づけること及び運動による生理学的な利点の可能性を調査するためには、より多くの個体でさらなる研究を行う必要がある。

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Introduction

Figure 1 | The subject leopard gecko for this study.

Play, or play-like behaviours are reported across all classes of vertebrates: mammals and birds, amphibians (frogs) and fishes,[1][2][3][4] and even in some invertebrates[5][6][7][8][9] indicating play-like behaviours has broad occurrence across animal kingdom. In non-avian reptiles (hereafter reptiles), play or play-like behaviours exist. However, few have been reported in scientific literature, and none is mentioned in standard pet/companion handbooks/guides.[10][11][12] Examples of reptile play include monitor lizards (*Varanus macraei* and *Varanus prasinus*), crocodilians, Nile soft-shelled turtles (*Trionyx triunguis*) and thick-toed gecko (*Chondrodactylus turneri*) engaged in play under captive environment.[13][14][15][16] Of these examples, Monitor Lizards are considered prime candidates for observing play in reptiles due to their large body size and high metabolic rate.[17] They are also considered quite intelligent per several reports of their learning and problem-solving ability.[1][18][19][20] This concept, added to the difficulty in designing a play environment, could be the reason behind the lack of studies in smaller reptile play. Only one study has been conducted to show small insectivore reptiles play. The study by Barabanov *et al.*, 2015 showed object play by thick-toed geckos.[16] In the study, the geckos were placed in a crewless spacecraft and orbited for 30 days in space under microgravity. The study showed the geckos engaging in play behaviour by removing and interacting with a collar worn by the geckos under weightless microgravity conditions. Although the study showing play behaviour by the gecko is scientifically valid, due to the unique experimental environment, it is difficult to translate the finding to a captive environment at a home setting where most pet reptiles are kept. Therefore, calling for further research and different approach in observing play behaviour is required if it were to be applied in a captive environment.

Animal play is divided generally into locomotor/rotational, object, and social play, though all can co-occur, although these are not strict categories as play can overlap in multiple categories.[1][21] Locomotor/rotational play is performing intense or sustained locomotor movements, often without any apparent immediate reason or stimulus. Object play is defined as an animal's mouth, paw, push, pull, grasp, lift, hit, carry, and otherwise manipulate objects that seem to provide no immediate benefit, unlike food or nesting material. Social play is defined as when play is directed at conspecifics or other animals taking on the role, at least partially, of a conspecific.[1]

Five criteria have been developed to recognize any of the three types of play that can be applied to all animals, including reptiles.[1][22]

The set of five criteria are:

1. The performance of the behaviour is not fully functional in the form or context in which it is expressed; that is, it includes elements, or is directed toward stimuli, that do not contribute to current survival.

2. The behaviour is spontaneous, voluntary, intentional, pleasurable, rewarding, reinforcing, or autotelic ("done for its own sake").

3. The behaviour differs from the ''serious'' performance of ethotypic behaviour structurally or temporally in at least one respect: it is incomplete (generally through inhibited or dropped final elements), exaggerated, awkward, or precocious; or it involves behaviour patterns with modified form, sequencing, or targeting.

4. The behaviour is performed repeatedly in a similar, but not rigidly stereotyped, form during at least a portion of the animal's ontogeny.

5. The behaviour is initiated when an animal is adequately fed, healthy, and free from stress (e.g., predator threat, harsh microclimate, social instability), or intense competing systems (e.g., feeding, mating, predator avoidance). In other words, the animal is in a ''relaxed state.''

In this study, the subject observed is a leopard gecko (*Eublepharis macularius*). Leopard geckos are small nocturnal insectivore reptiles native to deserts of Middle East Asia (India, Pakistan, and Afghanistan) commonly kept in captivity and are the third most popular reptile pet globally.[23] In some countries, it is the most popular pet reptile.[24] The significance of showing whether the leopard gecko plays or not may allow for improved care for the popular pet by possibly introducing enrichment item(s) to play to improve their welfare.

In this study, a leopard gecko was examined via video recordings using a running wheel that is commercially available and often used for rodent pets such as hamsters. A running wheel was chosen in this study based on 1) a study showing a wide range of wild animal species using a running wheel at their own will even in the absence of external reward, indicating possible usage for "fun" – i.e., for their own sake.[25] The study revealed that mice, rats, shrews, frogs, and slugs caused the running wheel movement. The study could not conclude whether the behaviours shown by the animals were play, and no wild reptile used the wheel. However, given the wide range of animals used it, with the right opportunity and observations, there was no reason to reject that a running wheel could serve as a play item for reptiles too. 2) Leopard geckos are known to react towards novel enrichment items [26][27], and several anecdotal reports are on social media and blogs online where leopard gecko owners claim their geckos used a running wheel repetitively, showing they were "playing" with it. 3) use of a running wheel could be interpreted as locomotion play.

With a replicable home laboratory setting, this study primarily aims to evaluate whether leopard geckos show any locomotor play behaviour using a running wheel.

Materials and Methods

Animal

The subject was an adult female, captive-bred leopard gecko (*E. macularius*), the author's companion animal (Figure 1). This gecko is approximately 12 years of age which is considered old as the normal life span of a pet leopard gecko is around 10 years (the longevity record for a female leopard gecko is 20 years and ten months[10]. The gecko had a clean medical history and showed no abnormality before and during the study. It weighted 49 grams and its snout-to-vent length of 12 cm.

Figure 2 | It was maintained at ten h 45 min day, 13 h 15 min night cycle with lights on at 07:00 and off at 17:45. 1) wet hide 2) a water bowl with fresh water provided daily 3) a hammock 4) a dry hide 5) an artificial bridge 6) the running wheel 7) a magnet glued onto the wheel to trigger the cycle counter sensor, which is circled at the bottom of the wheel 8) an artificial rock. The space between the wheel stand and the lowest part of the wheel was adjusted to ensure the space was not wide enough for the gecko to fit, thus mitigating the gecko in going under the wheel and avoiding potential accidents.

Enclosure, the play item, and the feeding pattern

The gecko was kept in a wooden enclosure (45cm x 45cm x 30 cm — length × width × height, handmade) containing a water bowl, a wet hide, an artificial rock, a hammock, a dry hide and an artificial bridge. While these enrichment items have been present before the study, the play item, a running wheel (hereafter, the wheel) (Amazon.co.jp ASIN B08WJWZ175 SANKO Silent Wheel Flat 19 Clear), was newly introduced (Figure 2).

The wheel had a diameter of 19 cm, a width of 7 cm, a circumference of 597 mm, a weight of 390 g. The wheel size was chosen as the diameter is longer than the gecko's snout-to-vent length, minimising stress on the gecko's spine when curving to walk on the wheel. A uniform solid surface was chosen for the wheel instead of a wired wheel to prevent the gecko's toes or tail from being trapped between any gaps. The wheel had a closed design meaning there is only one entry point to the wheel. The wheel was set up in the enclosure per the manufacturer's instructions.

The wheel was equipped with a commercially available cycle counter (bought from a local store which can also be found on Amazon: ASIN: B013E0OMUG *SunDIng cycle computer*) to count the distance travelled. The cycle counter uses a small magnet placed on the outer side of the wheel, and when the magnet passes over a

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sensor, it counts the distance. The magnet used was not from the cycle counter package, which weighed 3.00 g, but a lighter 0.90 g magnet available from a local gadget store was used instead. The lightest magnet sold locally reduced the magnet weight, negatively impacting the wheel weight. The cycle counter was manually validated before usage to confirm that the cycle count sensitivity was the same between the two magnets.

The enclosure was equipped with two heat sources, a panel heater for 24 hours and a heat lamp during the day.

During the entire experimental period, the dry bulb temperature during the day was kept at 27-28-degree Celsius, nighttime dry bulb temperature at 24-25 degrees Celsius. Relative humidity was kept at 30-45%.

The gecko was fed every seven days with *LEOPA DRY* (*Meal Replacement pellet designed and sold for leopard gecko, bought from Amazon.co.jp: ASIN: B07SCRY8BN)* using a tweezer, given as much as the gecko would eat at one time (2-8 pellets/approx. 0.2-0.8 grams. Feeding pattern also noted in Table 1). The feeding frequency and meal type was kept the same as the animal's diet prior to the experiment. The number of pellets eaten was measured to assess if there were any differences in the amount of food consumed.

Observational Methods

To observe the nocturnal leopard gecko, a night vision (940 nm infrared light) motion detection camera (*Xiaomi Mi camera 2K* bought from Amazon.co.jp ASIN: B0BG5K42C2) was used to record the behaviour. The camera was ready to record when the lights went off from 17:45 and continued until 07:00 the next day for a total of 14 days. After 14 days, the cycle counter was kept for an additional seven days for continuous assessment of the wheel usage.

The camera's motion detection would automatically start the recording when the gecko moves out of its hide. The video record was used to measure wheel interaction episodes and total time engaged in the wheel. A number of wheel interaction episode is counted as one when the gecko enters the wheel (entry to the base of the wheel inside with its forelimbs first, followed by hindlimbs) then leaves the wheel ultimately (all its limbs were outside the wheel). Total engagement time is defined as the total time the gecko spends actively using or resting within the wheel during each observation day. The cycle counter was used to analyze the gecko's movement distance using the wheel.

Statistical Analysis

A Pearson's correlation was assessed to test any correlation between the duration spent on the wheel and the number of wheel interaction episodes, the travel distance recorded on the cycle counter to show whether the gecko merely used the wheel as a hide or for locomotion.

Results

The gecko's behaviour pattern of 35/336 hours of movement recorded over 14 days was analysed from the video recording and cycle counter. No locomotion was observed outside of the hide for six days as the gecko remained in its hide.

Figure 3 | Example video stills of the leopard gecko approaching and getting onto the wheel (top left, top centre, top right) and walking on the wheel (bottom left, bottom centre, and bottom right)

The video recording showed the gecko took on average 81 minutes (SD = 89, minimum 11, maximum 247 excluding non-active day) after the lights were out to come out of the shelter and approach the wheel, followed by entry to the base of the wheel inside. Once in the wheel, the gecko started walking (Figure 3 and Figure 9 (under supplementary material)), and this occurred every time the gecko reached inside the wheel. The gecko would stop walking to take a rest either on the wheel or by leaving the wheel, going back to the wet hide after a few seconds to a few minutes of continuous walking. The gecko would then come back to the wheel to walk again and repeated this behaviour throughout the observed period. No running was observed.

Figure 4 shows the number of wheel interaction episodes of the gecko on each observation day and its correlation with the gecko's total time engaged in the wheel. The correlation was found to be a moderately

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positive correlation, r (12) = .53, p = .51 (not significant at p=.05). A mean of 11-wheel interaction episodes was found (SD = 16, minimum 0, maximum 47) per observed day. The gecko spent an average of 133 minutes (SD = 188, minimum 0, maximum 525) on the wheel per observed day.

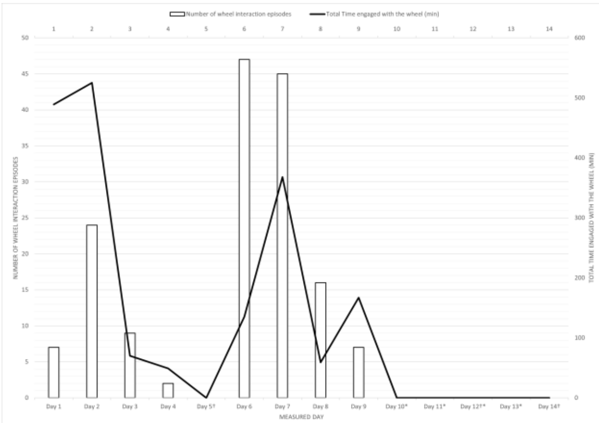

Figure 4 | Combination chart of the number of wheel interaction episodes with the wheel and Total time engaged in the wheel per measured day. †Feeding day (Day 5, 12, 14) *Shedding (Day 10-13).

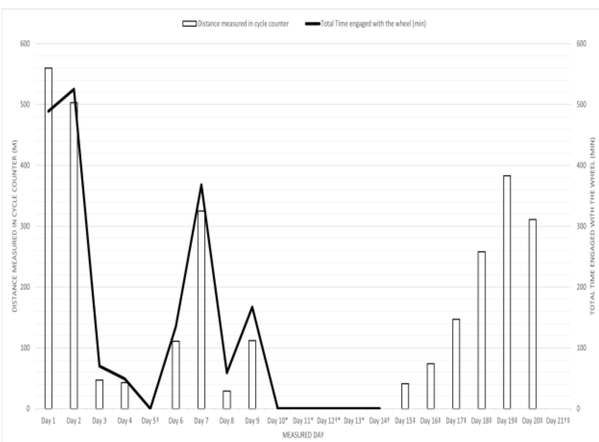

Figure 5 | Combination chart of travel distance measured by cycle counter and total time engaged in the wheel per measured day. †Feeding day (Day 5, 12, 14, 21) *Shedding (Day 10-13) ‡Observation from cycle counter alone thus excludes engagement time with the wheel (Day 15-21).

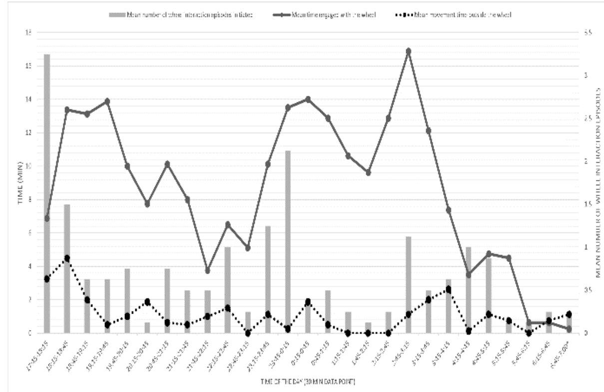

Figure 6 | Combination chart of the mean number of wheel interaction episodes initiated, mean time engaged with the wheel, the mean movement time outside the wheel, per measured time of the day at temporal resolution of 30 minutes. *Last timepoint exists for 15 minutes as light went on at 7:00 ending the overnight measurement.

The odometer displays from the cycle counter showed a mean distance of 124 meters (SD = 177, minimum 0, maximum 560) per measured day. The maximum daily movement distance surpasses some existing diurnal lizard specifies of similar size[28]. No behaviour observations were present that triggered the wheel's movement other than walking inside the wheel. The distance measured on the cycle counter and total time engaged in the wheel (Figure 5) showed a strong positive correlation, r (12) = .99, p = .00001 (significant at p=.05). Table 1 summarizes noteworthy behavioural observations at each measured day and lists distance measured on the cycle counter.

Figure 6 shows the combination chart of mean number of wheel interaction episodes initiated, mean time engaged with the wheel and the mean movement time outside the wheel per measured time of the day at temporal resolution of 30 minutes (with exception of last 15 minutes due to lights went on at 7:00). All three measurements showed fluctuation across the measured time, with higher activity level observed in the first 60 minutes after lights out than the last 75 minutes before dawn. This is in line with description of wild leopard gecko where per Khan (2009), the wild leopard gecko would leave its resting place soon after sunset and comes back just before dawn.[29]

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Table 1: Travel distance measured on the wheel per measured day using cycle counter and any noteworthy behavioural observation is listed.

The distance measured in cycle counter	Measured Day	Behavioural/general observation comment
560	Day 1	The gecko weighed 49.08 grams (the last feeding occurred minus two days).
503	Day 2	NAb
47	Day 3	NAb
43	Day 4	NAb
0	Day 5	Feeding at 15:00. Consumed eight pellets. No movement outside the wet hide was observed, confirmed by video recording and the cycle counter.
111	Day 6	NAb
325	Day 7	NAb
29	Day 8	NAb
112	Day 9	NAb
0	Day 10	No movement outside of wet hide. Pre-shedding was observed via whitening of the skin during the day.
0	Day 11	Same as above
0	Day 12	Same as above. Feeding at 15:00 but only consumed two pellets.
0	Day 13	Shedding completed.
0	Day 14	Feeding at 15:00. Consumed five pellets.
41	Day 15a	NAb
74	Day 16 a	NAb
147	Day 17 a	NAb
258	Day 18 a	NAb
383	Day 19 a	NAb
311	Day 20 a	NAb
0	Day 21 a	Pre-feeding weight was 51.64 grams. Feeding at 15:00. Consumed eight pellets.

[a] post-video recording period for measuring distance only. [b] Not Applicable = no noteworthy observation.

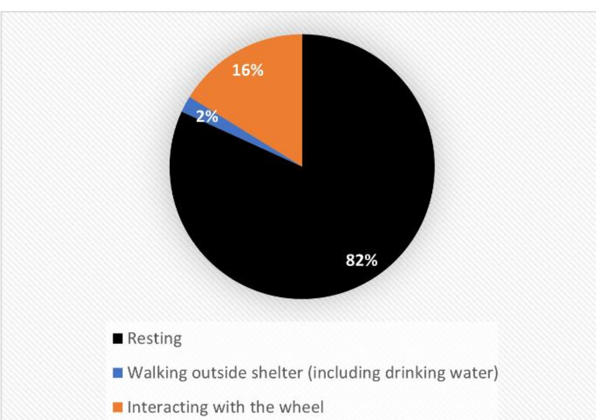

Figure 7 | Activity budget of the leopard gecko throughout the eight days the gecko was active (excluded days 4, 9-14 due to no activities out of wet hide were observed)

The activity budget was determined based on the analysis of the video recordings. It showed 82% (9426 minutes) resting in the wet hide, 18% (2094 minutes) active, of which 16% (1862 minutes) were interaction with the wheel, and 2% (232 minutes) spending time outside the wheel/hide during the eight days which showed activity outside of the wet hide (Figure 7). Despite the large difference between the surface area of the enclosure (1816 cm^2; after deduction of the area of the wheel) and the wheel (209 cm^2; the area were the gecko could walk), the gecko selectively chose to spend more time being active over the wheel than any other area within the enclosure.

The gecko interacted with an enrichment item artificial rock (0.026%/3 minutes) within the 2% time outside the wheel/hide. No interaction with other enrichment items was observed. Figure 8 shows the activity budget for Day 2, which was the most active day observed. It showed 61% (875 minutes) resting in the wet hide, 39% (565 minutes) active, of which 36% (525 minutes) were interaction with the wheel and 3% (40 min) spending time outside the wheel/hide. No interaction with other enrichment items was observed on Day 2.

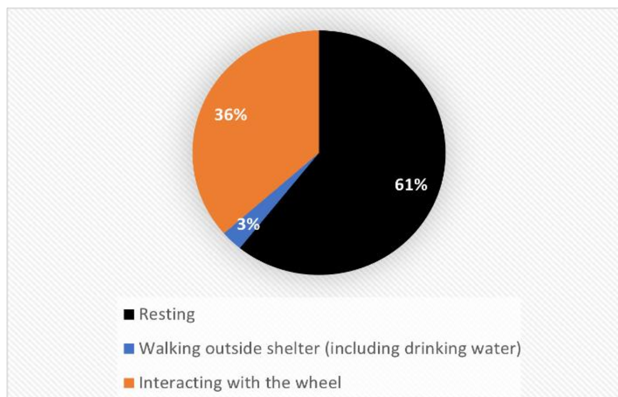

Figure 8 | Activity budget of the leopard gecko at the most active day of measurement (Day 2)

Feeding frequency of every seven days was kept, except during the ecdysis from Day 10-13; feeding conducted on Day 12 showed little food consumed (two pellets); therefore, on Day 14, another attempt at feeding was conducted. On Day 21, the last feeding occurred during the study observation period. Table 1, Behavioral/general observation comment column notes the feeding timing and consumed number of pellets.

Discussion

Let the observation results be applied to the five criteria for classifying play to determine if the leopard gecko played using the wheel.

Criterion 1:

Walking on the wheel is by no means biologically linked with the gecko's immediate survival such as gaining food, mate or shelter, as the gecko has survived for the past 12 years without it. While the walking typically serves the animal to move between locations, however the wheel walking does not transport the animal anywhere. Furthermore, the wheel is plain and white coloured with no landmarks, thus it does not mimic movement between locations either. Therefore, the repetitive interaction with the wheel does not serve any immediate function either.

Criterion 2:

The gecko was not forced or trained to use the wheel, nor were any rewards given. The gecko repeatedly walked on and off the wheel during the observed period, showing an ability to leave the wheel voluntarily. The number of wheel interaction episodes, total engagement time in the wheel and the total distance walked on the wheel showed large variances within the 14 days observation period. This suggests that the interaction with the wheel itself was voluntary, intentional, spontaneous, and performed for its own sake.

Criterion 3:

While walking is a natural behaviour, voluntarily doing so on the wheel rather than purely walking on the enclosure's substrate could be interpreted as a modified behaviour. The total engagement time in the wheel / total distance walked on the wheel as well as the activity budget is exaggerated behaviour compared to low interaction levels with other enrichment items and the gecko spending vast majority of its time outside the hide on the wheel rather than moving in any other area of the enclosure.

Criterion 4:

This criterion is possibly the most debatable. There is an ongoing debate about whether wheel running in mice is stereotypical behaviour.[30] At least some mice and rats are known to show pathologically stereotypical behaviours with wheel running, such as continuing to use the running wheel until starvation.[31] A study by Meijer & Robbers 2014 showed wild mice also used a running wheel, suggesting wheel running in mice is not stereotypic,[25] although some authors disagree with this conclusion and wild mice could show stereotyped behaviour.[32][33][34] However, a similar behaviour seems to be occurring, although the gecko only showed walking and not running.

Nevertheless, at least for the gecko of this study, during the observation period, the gecko repeatedly interacted with the wheel voluntarily. The duration of interaction with the wheel differed across the observation period. This variability in the duration/interaction episodes with the wheel within and between the observed days suggests that the behaviour is not strictly rigid. Its feeding patterns and daytime resting patterns did not change. Post-feeding and pre, during and post-shedding (ecdysis) behaviour directly translated into cease of the interaction with the wheel, which was an expected response from a physiological point of view as during digestion and shedding, reptiles are known to be less active in prioritizing their energy expenditure for these physiological events.[35] Figure 6 also indicated the gecko's nocturnal behaviour was in line with wild leopard gecko showing the gecko returning to its hide towards the dawn[29]. Therefore, based on the gecko's behaviour, it was not behaving pathologically stereotyped. The captive environment may be driving the gecko to engage in wheel walking to keep stimulated, as the enclosure is more limiting compared to the wild.

Criterion 5:

The gecko had no known or present health issues, fed with unchanged frequency before the wheel introduction with food quantities as much as she wanted and no changes to its weight significantly. The dry bulb temperature/humidity conditions also stayed consistent. Handling was avoided to reduce potential stress on the gecko during the observational period other than at the start and end of observation to weigh the gecko. The gecko displayed typical healthy behaviour.

Based on the above, the study data shows that the gecko's behaviour meets the five play criteria.

The highest total engagement time in the wheel / total distance walked on the wheel was in the first two days of the wheel introduction, indicating novelty response was present. However, the gecko continued to use the wheel when it was not under any physiological event, such as post-feeding digestion; thus, the gecko continued to show some motivation to interact with the wheel. The gecko is known to react to new enrichments, and this study showed that a gecko of older age can still show such a reaction to a new enrichment and learn to use it.[26][27]

The by-product of locomotion play, especially using a running wheel designed to be walked or run by an animal, is that the animal will get a certain level of exercise. Voluntary wheel running by mice has shown some benefit to their health by increasing the average or median lifespan of mice by up to 17% and protection from sarcopenia.[36][37] However no such study exists in leopard geckos thus physiological benefits, if any, of voluntary exercise in leopard gecko is a topic for further investigation.

The surplus energy theory suggests that animals engage in play, especially locomotion play, when they have excess energy that can be expended without impacting their survival.[1] Captive animals, including leopard geckos, kept in limited space that is well fed, should have enough energy to spare and thus would be a candidate reptile to engage in play behaviour. Unfortunately, there are no explicit scientific references on wild leopard gecko behaviour or their activity budget, so this study data cannot be compared against the conditions of the wild animal. Although the mean play activity budget of 16% does not surpass published work on Nile soft-shelled turtle,[15] it surpasses some mammals shown to have ~10% play activity budget[15] and it is similar line to results by *Bashaw et al.* (2016) who reported that their geckos spent about 20% of their time in engagement with object enrichment item.[26] Walking distance of 560 meters on one of the peak days observed surpasses daily movement distance data on similar-sized diurnal lizards,[28] indicating the leopard gecko is likely displaying exaggerated behaviour (criterion 3).

Zieliński (2023) showed that even with 45 min of observation, after enrichment items were provided to leopard geckos that were kept under low enrichment enclosures showed a higher frequency of enrichment interaction than those geckos kept under biotope terrariums which are considered as high enrichment environment. The study also showed that even a leopard gecko from biotope terrariums increased exploration when a new enrichment item was introduced,[27] indicating the leopard gecko kept under high enrichment enclosure still interacted with enrichment novel enriching object.

The distance walked on the wheel would be unlikely to be met in any typical enclosure environment at home setting, unless a gecko shows pacing in a stereotyped manner along the enclosure. Therefore, a running wheel may be an enrichment item to be considered from an animal welfare point of view if voluntary locomotion activity such as walking could be proven beneficial. Although this does not mean the geckos should be kept in small spaces, having a large space enclosure may not be possible for many pet owners, and it is indeed not a strict requirement to do so. The most common enclosure is a 10-gallon (38 litres) terrarium for keeping a single leopard gecko, and it is suggested by the two best sellers of leopard gecko pet guides in Amazon.[10][11] A running wheel could fit into an enclosure of this size if the enclosure has enough height. A caution here is that a wheel cannot be introduced to an enclosure where multiple leopard geckos are kept to avoid unintentional injury, such as when one leopard gecko uses the wheel. If another gecko gets too close to the moving wheel, it could accidentally go into contact with the moving wheel. This caution aligns with the manufacturer's instructions for the running wheel for pet rodents.

The limitations of this study must be emphasized. First, the findings are based on a single leopard gecko; thus, this study alone cannot be generalized to this species. Further studies using more animals of both sexes and different life stages is required. Studies have shown that juvenile animals show higher engagement in play/play-like behaviours,[1][7][38] thus significance of investigation using the juvenile leopard gecko would be high. Second, the study's measurements are taken in a relatively short-term, primarily assessing play behaviour. A long-term study to determine any changes in activity budget and walking distances is required to determine any changes in seasons, lighting hours, dry bulb temperature, and feeding patterns. In addition, the walking distance measured on the wheel does not directly translate to field walking distance because the friction and weight of the wheel affect performance, at least in mice,[39] but logically applicable to any animals' locomotion. Also, wheel rocking occasionally occurred when the gecko ceased locomotion, sometimes coinciding with the magnet's passage over the cycle counter sensor, resulting in an overestimation of cycles (approximately 1/14 cycles = 7% error rate). Therefore, cycle count alone did not provide an accurate measure of distance travelled. However, distance travelled strongly correlated with time spent on the wheel, despite approximately 30% of that time being spent stationary. Thus, cycle counter distance can serve as a proxy for the gecko's level of interaction with the wheel. Third, it is possible that the size of the enclosure could affect amount of interaction with the wheel. Finally, to the author's knowledge, no scientific observations of wild leopard geckos' activity levels have been reported; thus, it cannot be determined that the activity levels shown in this study are within the range of the species.

Conclusions

The study found the leopard gecko voluntarily learned to walk on the running wheel at its desired duration, repeating this behaviour throughout the 14 days observed, yet not to the extent of pathological stereotypy behaviour. It met the play behaviour criteria; thus, it is safe to conclude that the leopard gecko played. Specifically, it falls under locomotion play. Whether this is a common feature among the species or within similar-sized reptiles remains to be explored.

The study also revealed the possibility of using a running wheel as an item in investigating the exercise physiology of leopard geckos. The introduction of the wheel, given that it is safely set up and a leopard gecko is singly kept may serve as an enrichment item for the leopard gecko. Long-term observations with multiple leopard geckos would be required to confirm its benefits or appropriateness from an enrichment point of view.

Additional information

Supplementary Material

Video Example of the leopard gecko walking on the running wheel

Figure 9: Video example of the leopard gecko walking on the running wheel.

Competing interests

The author declares no conflict of interest.

Ethics statement

The study followed animal research guidelines applicable to all researchers publicly available from Ministry of Education, Culture, Sports, Science And Technology – Japan (country of where study conducted). No animal was hurt during this study.

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